SCIENCE

FRIDAY, MAY 19, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

TEACHING AND PRACTISE[1]

IT would be impossible to address this congress without a word of affectionate tribute to the memory of three great men who have presided over these meetings in years that have passed, figures, alas, that we shall not see again.

Fitz, the patient, discriminating student, the wise, inspiring teacher, whose keen eye and orderly mind shed light upon obscure corners of the art of medicine; Mitchell, the poet, the brilliant physiologist, the acute and sympathetic reader of men's minds, the great practitioner; Trudeau, the optimist who, in his long journey through the "valley of the shadow of death," led so great an army of sufferers to the land of light. 'Tis a heavy loss. But what a varied and lasting inspiration the lives of these men have left for us and for the world!

In the last several years, especially through the activities of the American Medical Association, the Carnegie Institution and the General Education Board, questions relating to medical education have been discussed very actively in America, and the changes and improvements in our methods of teaching and in the character and training of those who teach have been greater probably than in any other like period in the history of American medicine.

The relations between teaching and practise in hospital and in university have of late been the subject of especially vigorous controversy in this as in other countries. To one who for five and twenty years has

[1] Address of the president of the Congress of American Physicians and Surgeons delivered at Washington on May 9.

been engaged with more or less activity in the practise as well as in the teaching of medicine, who has been associated with two universities in which interesting experiments in medical education are now in progress, these discussions have been of absorbing interest.

With all the divergences of opinion and amid all the heat of discussion the goal aimed at is almost universally the same. It is our desire that the hospital, the school of medicine and the teaching staff shall be so organized that the ultimate service to humanity may be the largest; that we may gain greater knowledge of disease; that we may acquire more efficient means, public and private, of recognition, prevention and alleviation of the innumerable ills to which the human race and its inarticulate companions and servants are heir: that we may become more efficient in the care of our patients; that we may train better physicians. These are the main ends of the study of medicine. It has seemed to me well to devote this hour to a discussion of some of the phases of the relations between practise and teaching.

In the early days, the study of medicine in this country was begun in the office of the practising physician. By and by there developed schools of medicine in which the teachers were successful practitioners. The first of these schools were associated with hospitals, and although the body of teachers was not large, yet John Morgan in his famous address on medical schools, early pointed out the necessity that special branches of medicine should be taught by men who had given their greater attention to these branches in practise. The professors of medicine and of surgery who bore the brunt of the teaching and directed their departments were usually busy men much sought for by the public in their community; and the teaching in the old days consisted largely of didactic lectures, with but limited demonstrations. Only thirty years ago, at the time when I was a student of medicine, the duties of the professor of theory and practise consisted solely in the delivery of several didactic lectures a week; those of the professor of clinical medicine consisted in the giving of two demonstrative clinics and one clinical conference. An assistant professor held one recitation a week. An occasional ward visit was given in one or another of the large hospitals, but these opportunities were improved by but a small proportion of the students. Physical diagnosis was taught during the second year to a class of about ninety by three instructors in several hourly exercises a week in sections of 20–30. This constituted the work of the department of medicine.

The direction of such a department was properly confided to a distinguished practitioner, a man of wide experience; and its management involved demands upon his time no greater than were compatible with the suitable performance of his hospital and private duties.

In such a school of medicine the clinical instruction of a single medical department or unit could be, and often was, carried out in a variety of hospitals—those hospitals with which the professors of medicine had the good fortune to be connected. The only association between the university and the hospitals was, in many instances, an amicable agreement on the part of the latter to allow instruction in the out-patient departments, through public clinics in amphitheater and operating room, and to a certain limited extent in the wards. There were no university laboratories connected with the hospital. University laboratories existed at another center which might or might not be near, or at a considerable distance from the hospital. These laboratories depended in large part upon the hospital

for their material, but did not often, excepting through the good will of the clinician and pathologist, control the supply; and, excepting to a very limited extent, the laboratories at the school rendered no especial service to the hospital.

In such a school of medicine a hospital was an accessory, a very close and valuable accessory to be sure, but yet an accessory to the department of medicine. And in discussing matters of medical education the hospital and the medical department of the university might be considered separately.

To-day the hospital must be considered not as an accessory to the department of medicine, but as its vital center. One can scarcely conceive of a school of medicine wholly independent of its hospital. The laboratories for the study of the chemical and anatomical and physiological phenomena of disease can not well exist at a center removed from the hospital, or under the control of individuals other than those directly associated with the hospital management. On the other hand, the hospital in many instances has come to depend largely on the cooperation of the university in the performing of some of its most essential functions. Professors, assistants, undergraduate students all go to form a corps of hospital servants invaluable to the institution. In a word, the relations between hospital and school of medicine are so close and intimate to-day that a discussion of the organization of a medical or surgical clinic, or of a department of pathological anatomy, presupposes the assumption that hospital and university be under one management or in such close affiliation as to form a single working body. For the ends aimed at by both hospital and school of medicine are closely related. The main, specific purpose of the hospital is the care of the sick; that of the school is the training of physicians. The care of the sick can be carried out best through the employment of physicians of the highest order, and for these the hospital turns to the school. But to offer the student the best possible training the school must have opportunities for the study of disease and of pathological material, and for these opportunities it turns to the hospital. The delicacy and complication of modern methods of chemical and physical diagnosis demand laboratories and laboratory equipment which involve considerable and steadily increasing financial outlay; they call, moreover, for students of the best chemical and physical training to preside over these laboratories. This has brought it about that general hospitals which are not integral parts of a university must turn to universities for assistance, or spend, for the installation of independent laboratories and apparatus and for the employment of salaried heads of these departments, a sum of money which to many institutions is almost overwhelming. The university laboratories of bacteriology, serology, physiological chemistry and so forth where studies which are, in many instances, most practical, are to be made, should be in or adjoining a hospital. Thus the economy and mutual advantages of cooperation are clearly apparent. And more than this, in the true university hospital which is centrally situated, a community of interest is constantly drawing together the clinical and so-called scientific departments. This is particularly true of the departments of physiology, physiological chemistry and pharmacology—and to the great mutual advantage of hospital and of university.

To-day in the better equipped and organized institutions there is in ward and laboratory, in hospital and school a common effort to contribute to the advance of the science and art of medicine in its broadest sense. Both hospital and school are centers of original research. However cordial and

however free a cooperation there may be between the university and hospitals situated at a distance from the central plant, one must acknowledge the necessity to a modern medical school of one central hospital. And so it has come about that any discussion of the organization of a modern medical clinic presupposes that which, for purposes of illustration, may be called a "university hospital" as its center, and calls for a consideration of certain hospital arrangements as an integral part of the problem. Such a hospital should be organized upon a basis entirely different from that which used to prevail and still exists in many institutions. The medical clinic or the surgical clinic, if it is to do its full duty to the public, to the hospital and to the school should be a well-organized unit under the control of a single director and a corps of associates and assistants. And of this corps of associates and assistants, some at least, preferably a considerable number, should be salaried men, who are required to give a large part of their time to their hospital and university work. All of these men should be members of the teaching staff of the university. Only in a clinic organized on some such permanent plan can constructive research be carried out or systematic instruction given. The old-fashioned rotating service is incompatible with the ideals of a modern hospital or university.

According to the size of the institution one or more such clinics may exist, and there is no reason why in a large hospital there might not be two or more separate clinics, or why in a given university there might not be several more or less independent professorships of medicine with clinics at different hospitals, if the means were forthcoming to supply the necessary material for the full organization of such clinics.

But to return again to the organization and constitution of a single department of medicine as compared with that of thirty years ago. The changes in the method of teaching clinical medicine have been great. Demonstrative clinical lectures remain an important element of medical teaching. But the place of the didactic lecture has largely been taken by practical instruction before small groups at the bedside. This involves a considerable increase in the teaching staff and increases greatly the amount of time which the teacher must give to his work. Thirty years ago the professor of medicine may have been expected to give two or three hours a week to his classes. To-day he could hardly be expected to devote less than six or eight hours to personal teaching. The problems of the teaching of physical diagnosis in its restricted sense are not so different from those of thirty years ago; but to-day it is generally recognized that the university should offer the student far more individual practical training than he used to receive. In the old days, three men, let us say, were entrusted with the teaching of a class of ninety; to-day the work would be distributed among six or eight at least.

Thirty years ago there was no such thing as a clinical laboratory, and clinical microscopy and chemistry were not taught in the medical department. Indeed, there were no special medical laboratories. To-day a modern medical clinic must, in the first place, control a clinical laboratory presided over by men who are called upon to give a considerable portion of their time to the training of the student in a large variety of methods of examination of secreta, excreta and body fluids; and this laboratory should also be a center for scientific research. Thirty years ago, it was easy for one man to preside over the entire department of medicine and to conduct his practise as well. It is extremely difficult, if not impossible, for

a practitioner to preside over the clinical laboratory to-day, and at the same time to do justice to his responsibilities as a physician.

Chemistry as related to the practise of medicine thirty years ago played a relatively small part in the medical curriculum. It was mainly restricted to its application to the study of urine, and those studies were for the most part of a simple character. To-day the chemical problems involved in the studies of human metabolism and used in the art of diagnosis are numerous and complicated, and are steadily increasing. No well-equipped medical clinic can exist without a department of chemistry, which should be presided over by a man of training and experience, capable of conducting and directing research and of overlooking the necessary studies of a variety of problems which arise in the wards of the hospital, for, as has been pointed out, no school of medicine can fulfil its mission to-day without intimate association with an adequate hospital. It is not easily conceivable that the director of the chemical laboratory could find time for medical activities outside the clinic.

The older methods of physical examination, so called, although mastered only by practise and experience, were yet mechanically simple. To-day, however, for the exploration of the human body and its activities, there are employed physical procedures which involve the use of instruments of great delicacy and demand a highly specialized technique. And subdepartments of radiology and electrocardiography each with its laboratory and its director, are necessary constituents of the modern department of medicine.

The medical clinic should also have a special department of bacteriology and serology, another subdepartment the direction of which demands much of the time of an experienced student. Of these laboratories also the director should be one who is able to organize, conduct and stimulate research.

Again, there should be in association with every medical clinic a department of physical therapy for the study and application of mechanical, hydro- and electro-therapeutical methods; and especially for the teaching of massage and of general physical training. Such a department might, it is true, be under the combined control of affiliated medical and surgical clinics, but some of the responsibility for its organization and direction should lie with the chief of the medical service.

It has been said that the directors of these subdepartments could hardly be expected to give any essential part of their time to the practise of medicine. Are they therefore wholly to be removed from the care of the sick? Is the department of medicine to have under its control a number of subdepartments presided over by so-called "pure" bacteriologists, physiologists, physicists, chemists—men who are entirely removed from direct responsibility for the care of the sick? Far from it.

In the ideally arranged department of medicine, all of these men should have clinical duties and responsibilities—duties and responsibilities which, in a hospital, may be systematized. And in the properly organized department of medicine, although many of its members may in a sense be specialists, yet none will fail to acquire a wide general medical experience.

Let us now for a minute reconsider the problems which confront the director of a department of medicine to-day. The teacher of thirty years ago followed a relatively simple routine. The chief of a modern medical clinic finds himself the head of a complicated machine, involving the appointment of a large number of salaried assistants, the manipulation of a consider-

able budget, which alas! under present circumstances, rarely meets the demands of the situation, the coordination of a large staff of trained workers in clinical, chemical, physical, bacteriological, serological and physiological departments, and the organization of a system of group teaching to which he must himself devote a very considerable amount of his time. It is evident that the director of such a department should be a man who has had a rather broad training, who shall have had a basis of chemical instruction such as was impossible thirty years ago, and shall have spent a sufficient amount of time in work in each of the branches represented by the subdepartments of his clinic to enable him at least to comprehend the significance of the work which is there being done, and to carry out real supervision.

Time was when the teaching of medicine was, in great extent, a matter of authority. The student was led to accept precepts enounced *ex cathedra*. To-day the teaching of medicine is largely a matter of demonstration, of example, of practise. The student is inclined rather to distrust precept for which proof is not adduced; he is offered opportunities to study the symptoms of disease and its treatment by the bedside, and is instructed in methods by which he may control and confirm so far as may be, the assertions which he may read in the book or hear from the lips of the instructor. The method of authority has given way to the method of observation and inquiry.

Who should preside over such a clinic as this? Who is the ideal director of the modern medical department? Thirty years ago the professor of medicine was properly he who had obtained the greatest reputation as practitioner or consultant. This reputation was often not attained before the age of fifty, and was gained through the active practise of the art. Such a man, who with years, might or might not have attained financial ease, might suitably, in these days, have been called upon, at a nominal salary, to direct a department and to give the two or three hours a week which were the sum total of the time exacted by the teaching duties of the professor.

But to-day it would be extremely difficult, nay, it would be almost impossible, for a man with a considerable consulting practise to organize and direct a medical clinic, such as that which I have outlined, and, in addition, to do the amount of personal teaching which would be necessary. The practitioner, even if he be purely a consultant, is not master of his own time. He may limit his consultations to special hours, but he can not cut off the increasing calls which appeal to his sympathy and come at any moment. And even if he see ever so few patients, he can not control the complicating side-questions to which relations with any one ill human being are too apt to give rise.

With the consultant as with the practitioner *sensu stricto* the human influence is the most important element in his work. The preliminary conferences indispensable for the establishment of the necessary relations of sympathy between physician and patient, the interminable confidences of the nervous invalid, the unravelling of the tangled mental complexes of the psychoneurotic sufferer, the heart to heart talks, the breaking of sad news, the straightening out of the many complications which so commonly arise in connection with grave illness, the letters to physician and family, the interviews with friends and relatives—these, as the consultant well knows, are the duties that consume his time; but they are necessary and essential parts of his work. It is not the actual time that the physician spends in the study of his patient—that is often the smaller part of it. It is the accessory duties that render it impossi-

ble for such a man properly to combine active consulting practise with the responsibilities of the directorship of a large modern clinic.

To accept such a position would necessitate the abandonment of a large part of that physician's practise; this would mean the loss of the main source of his income, unless he were a man of independent means. If then the professor of medicine in a modern university is to be chosen from the ranks of those men who have acquired great experience through professional success, it will be necessary either that the university shall pay a very considerable salary, or that the professor shall be a man of independent means. Such a salary, unfortunately, if men of this class are to be obtained, would have to be quite beyond anything that is at present possible in most universities. The successful consultant is usually put to considerable expense for the maintenance of the machinery necessary for his work, and in many instances comes to maintain a sort of existence which involves large financial responsibilities. However much such a man might desire to avail himself of the fascinating opportunities offered by the directorship of a large medical clinic, it is too commonly the case that, by the time he has well entered upon his fifth decade he has already assumed responsibilities toward others which make it impossible for him rightly to abandon the sources of his income. But this, it seems to me, is not the essential feature of the situation. Is the physician who through years of practise has become the successful consultant, the man who is best fitted to direct a large department of medicine or surgery? By no means always. Indeed, in the majority of instances, it is another course of life which should best fit a man for a university professorship.

There has arisen gradually in this country a new class of consulting physician, the man who has deliberately planned his career from the outset, who has sought through long years of study in hospital and in laboratory, in association with large clinics, to gain in a concentrated fashion, as it were, that experience which may make his clinical opinion, both from a diagnostic and therapeutic standpoint, most valuable. Long-continued service in institutions in which proper opportunities for study and research are offered, is giving to the public to-day a number of men who, while thoroughly trained and practised in modern methods of diagnosis and treatment, have accumulated, at a relatively early age, a store of actual clinical experience such as is acquired in independent practise only after a much greater time and, in the majority of cases, with a loss of touch with some of the more recent advances in medical science. These men, the products of intelligent methods of hospital management and organization, are as a rule soon called on by their colleagues in more active practise for advice and assistance as general consultants. Men who have pursued such a career, which has inevitably involved at the outset a considerable financial sacrifice, are usually men of scholarly tastes who keep in touch with laboratories in which they may continue research and cooperate with their colleagues in practise in the study of the nature and treatment of diseases. It is from this class of men that the professorships of medicine are more and more likely to be filled. Such a man may well enter upon a professorship by the time, or even before, he is forty years of age.

This leads us directly to one of the questions which has been most actively discussed of recent years: Is a man who has obtained his clinical experience largely or purely in hospitals properly fittted to teach students the essentials of the practise of medicine?

A distinguished student of the problems of medical education has been quoted as saying essentially: "Diseases are the same in the rich and in the poor, in human beings and in animals. To the clinician the ward is his laboratory, and the study of disease in the patient in the ward is, in all essentials, the same as the study of disease in the animal in a laboratory. The only difference between the study of disease in hospital and outside is that in the hospital the patient may better be observed. It is a mistake to say that it is necessary for a professor of medicine to have had experience in private practise when the same experience may be obtained more intelligently and in a much more concentrated form in the hospital."

This conception which has, by some, been regarded as characteristic of the point of view of those who have favored the establishment of professorships of medicine on the so-called "full time" basis, has been looked upon as fallacious and dangerous by many of the opponents of certain modern tendencies in medical education.

"No man," they say, "is fit to teach students the art of the practise of medicine who has not himself passed through the experiences of the practitioner. Practise in a hospital ward is one thing; practise in the home of the patient, another. He who has been accustomed to rely on the trained nurse and on the many appliances and instruments of precision which a well-appointed hospital affords, can have little conception of the difficulties which he will encounter in private practise. He whose only experience has been with the trusting, unresisting patient in the general wards, will find himself at sea when treating the whimsical, critical, prejudiced, opinionated invalid in private life. He who has been accustomed largely to study serious diseases in the wards of the hospital will have small sympathy with, and little understanding of the trivial complaints of the supersensitive and nervous members of the more well-to-do classes. The conditions that he is called upon to treat are to be remedied in great part by minor regulations of habits and manner of life, of eating and drinking and smoking and exercise. His main duties consist in ministering to the minds of his patients—in kindly counsel and encouragement—in advice tending toward the alleviation of a thousand petty ills which he who knows that they will pass with time, does not even consider in himself—which the less sensitive patient in the ward barely notices. How can one who has never had this experience teach students the art of practise? Is it not folly to take away the teaching of medicine from the experienced practitioner and to give it to one who has had a training which might almost be called academic? Must we not regard this idea as the dream of the layman and of the laboratory student who, with all his scientific attainments, is yet wofully ignorant of the conditions of the doctor's life and of his duties?"

There is much truth in these objections. I should have no hesitation in agreeing that the medical experience suitable to qualify a physician as a consultant or a teacher of medicine can not well be obtained wholly in the free wards of a hospital. There is a great difference between the mental workings of the patient in the free ward and those of the average individual with whom one is thrown in private practise. The stolid indifference to outside influences shown by many patients in the general wards renders the study of disease in hospital not so very different, it is true, from the study of disease in the laboratory, but so soon as one becomes associated with patients of a higher mental order, problems in diagnosis and in treatment arise which are

much more difficult and complicated. It is, it seems to me, not easily possible for one who wishes to fit himself for practise as a consultant or for the teaching of medicine to gain that experience which he should have without a considerable association with individuals of more complicated mental constitution. Moreover, there are certain diseases which, strangely enough, are rarely seen in the free wards, yet are common in outside practise, diseases the recognition and management of which are of the utmost importance. I need refer only to angina pectoris. A man who is not familiar with the mental attitude of the people among whom he or his students are going to be thrown, who has not learned by experience successfully to navigate his bark through the mist of accessory problems which befog the antichambers of the sick room, is unable to give to the student much that will be of real value in the practise of medicine. But fortunately in many hospitals to-day, the great development of private wards offers abundant opportunity for the acquisition of just this experience. The man who desires to fit himself for a position as teacher of medicine or consultant should spend a considerable period of time in practise among the class of patients which is to be found in the large private departments of many of our hospitals. Such an experience gained in the hospital will afford him in concentrated manner just what he might obtain otherwise through a much longer period of time in private practise.

This is the general course of training which the aspirant to the professorship of medicine is likely in the future to follow. His elevation to the directorship of a large department of medicine or surgery may be directly from the clinic in which he has occupied a salaried position and to which he has given his entire energies, or it may come after some years of consulting practise during which he has preserved close relations with an active clinical department.

Recognizing the magnitude of the problems associated with the organization of a large medical clinic, it has been felt that such a department could best be presided over by men who were able to give their whole energies to the university in organization, in teaching, in the conduct and direction of research. And, notably at that institution with which I have been connected for more than twenty-five years, several of the clinical departments have been reorganized upon a university plan. Through the generosity of the General Education Board, the institution has been enabled to establish a staff of university professors and salaried assistants who take charge of these clinics for hospital and university. These men, freed from the calls of outside practise, are able to give their entire time to the service of the department in the care of patients, the promotion and conduct of research and in the teaching of medicine. And as is well known, the members of this staff have agreed to abstain from the practise of their profession for their own emolument.

The discussion associated with this experiment has been very active, centering largely upon the last mentioned circumstance—the withdrawal or abstention of the university professors and their assistants from private practise. Those who have objected to this procedure have regarded the plan as unwise and even unfair to the physician himself, to the hospital, to the students and to the public.

In the first place, with regard to the professor himself, it has been pointed out, and with justice, that there can be little relation between the salary which the university could or should pay to the professor of surgery or medicine and the gross income of the successful surgeon or consultant in

a large city. It has been asserted that the opportunities brought by a considerable income for wide association with the world at large are broadening to the character of the man and are indirectly of value to the institution with which he is connected; that furthermore it must be a very serious question to the physician himself whether he is justified in planning deliberately a manner of life which can never lead to wealth or real financial freedom, when there might be open to him an opportunity to give to his family and those dependent on him the advantages which come with a large income. Is he not, it is asked, giving up the "larger life" for the smaller, and will not the university in the end suffer by the loss of the wide domestic and international relations so often established by the professor who has the material resources to visit his distant colleagues in their clinics and to entertain them at his home? Will not the hospital, more directly, lose in the absence of those cordial relations which arise to-day from the association, as a consultant, between the chief of the medical clinic and the practising physician?

Will not the students suffer, it is asked, through their association only with men who have had a more or less academic training in a hospital, who are out of touch with the exigencies of actual medical practise? Will not practitioner and consultant suffer seriously in losing their control of the hospital material which is now to pass wholly into the hands of salaried men? And will not the public suffer? May it not indeed be regarded as an injustice to the public and to the practitioner that they should be denied the services of these men especially eminent in medicine or surgery, whose opinions presumably are of special value—these men who have been chosen to direct large clinics?

It can not be denied that these objections have a certain force.

The physician who, starting from modest beginnings, has acquired, by hard work, a large income can not underestimate the blessings and the opportunities that such a revenue brings to him and to those who depend upon him. But such incomes are rarely honestly gained without very hard, very confining work, and without real intellectual hardship to the practitioner if he be a man of scientific tastes or aspirations. To one who has the temperament and ideals of the student, the advantages of a university professorship can not fail to appeal very strongly. No man who covets a fortune should select a career of a university professor. He who enters upon such a life knows from the outset what his income is to be, and what the outlook for his family. He can not expect to be a rich man, and he must plan his life accordingly. But the compensations are great to one of scholarly tastes. The opportunities for study and research offered by the university clinics and laboratories, limited though they may be at certain times by the demands of teaching, the freedom from the uncertainties, the complications, the endless activities of the life of a busy practitioner or consultant, the hours for reflection, for rest, for recreation offered by the stated vacations—these, wholly apart from the privileges and responsibilities of the organization of a large department, are advantages so great that they will always attract men of the highest order.

"And the larger life?" Who can say what "the larger life" is in itself? The "larger life," alas, does not always go with wealth and that which surrounds it; and who shall say that the opportunities which come to the university professor of distinction and to those about him are more restricted than those which are open to the

practitioner and consultant? Certain of the luxuries of life the professor may be obliged to eschew, but there are other privileges which will be his that no money can buy.

It is true that the salary of the university professor has not, in general, advanced with the incomes of those about him, or with the general scale of living; and it is, I believe, folly to attempt to put the directorship of clinical departments on a university basis at salaries such as have been in the past offered to the professors in the strictly scientific departments. Nevertheless, no one can expect such salaries to be large as compared with the income of successful men in private practise. It should, moreover, be remembered that with the successful consultant, for instance, nearly one half of his gross income is often absorbed by the legitimate expenses of his practise. The burden of these expenses is lifted from the shoulders of the university professor whose fixed income represents a revenue of nearly twice that size with the consultant.

But the salaries of university professors, whether in clinical or scientific branches, should be materially—very materially—larger than they have been in the past, if these men are not expected by outside activities to add to their incomes. I can, however, see no reason why the salary of a professor of medicine or surgery should be larger than that of a professor in a so-called scientific branch. In business circles it is true that the salary depends purely upon the immediate market value, so to speak, of the individual; that he who can in the world of affairs earn but a modest sum is able to demand a far smaller salary than a man with larger practical earning capacity. The physiologist who devotes himself single-heartedly to his teaching and his researches might, if thrown on the world to gain his living, have but a relatively small earning capacity; the clinician, if he have attained a popular reputation, may, on the other hand, be in a position to make a considerable revenue.

Universities often obtain the undivided services, let us say of the professor of physiology, for an amount which was once but is not to-day a proper living salary for a man whose abilities and contributions to science entitle him to a comfortable and prominent position in the community; that position which it is to the advantage of the university that he should occupy. And such professors in many institutions sacrifice much to the cause of science.

This seems to me fundamentally wrong. These distinctions must eventually be removed, unless our universities are to remain as short-sighted as our national government and bring it about that our professorships, like our diplomatic posts, shall come to be situations which only men of independent means can fill.

But to return to the question of the professorships in the clinical branches. If the salary be adequate, there should always be efficient men whose ambition will be to occupy chairs of medicine and surgery even though they realize fully that the chances of the acquisition of a large income are small.

The objection that is so commonly raised as to the injustice and unwisdom of any understanding or agreement by which the directors of the departments of medicine and surgery should abstain from private consulting practise is one which, as a teacher and practitioner, has interested me greatly. As has been indicated before, it is not easy to see how the director of a modern university clinic, or the chief of a service in a large hospital organized on a similar basis, can give any essential part of his time to outside consultations. According to the tastes and character of the man, he will

probably give more or less of his time to private consultations at his clinic. To the consultant the puzzling and interesting pathological problems brought for his consideration by patients sent to his consulting room by colleagues at home and abroad, form the most valuable part of his experience. Such patients the professor of medicine and his associates will doubtless continue to see. They should form a great addition to the hospital clinic. Some of these patients they will desire to admit to the hospital for study. But these consultations the director of a large clinic could hold only at stated periods, and to this work he could give only a limited amount of time. It is difficult to see how it would be possible for the director of such a clinic to give the proper service to his department, and yet conduct anything like an active consulting practise outside the institution. Under exceptional circumstances, however, the professor will probably accept calls to outside consultations, but only under exceptional circumstances. The director of a large medical department must control his own time and his engagements. He who is openly occupied in general or in consulting practise can never truly be master of his time.

A curiously active discussion has risen upon a rather small point in connection with the practise of the salaried director of a medical clinic. In some clinics, as has been said, the understanding exists that the professor shall contribute whatever fees he may collect from private patients to the departmental funds. This procedure has excited vigorous criticism and opposition; it has, indeed, been considered fundamentally improper, subversive of the higher interests and principles of the medical profession.

This is a problem on which I have meditated seriously, and, look at it as I may, I can not but regard it as a rather small and relatively unimportant detail of a larger general question. The professor should naturally demand suitable compensation for his services to private patients. But whether such compensation should go directly to him, or should be turned over by him to the budget of his department, seems to me a matter of detail to be settled between him and university or hospital. I am at a loss to understand the attitude of those who see in this a question of principle.

Some time before the first experiment of a university medical clinic was put into practise, a distinguished clinician whose services were sought by a well-known institution, offered independently, for the organization of his department a plan, which is very similar to that which now exists at the Johns Hopkins University. This offer outlined the establishment of his professorship upon a purely university basis, with the explicit understanding that the income from any private consultations into which he might see fit to enter, should be added to the budget of his department. Such an arrangement might be regarded as a distinct protection to the professor. For the financial questions which relate to practise are to some annoying and disturbing. And if the salary paid to the university professor be in any way sufficient, I can easily fancy that the professor might prefer to have it understood that the income from any practise which he might care to undertake should go into the budget of his department. I can also fancy that others might feel differently; that they might prefer a complete independence, expressed or implied, in this respect. I can further fancy that the university or hospital might fear that if the professor once began to accept fees from private patients, he would be in danger of being drawn into practise to such an extent that it would interfere with his

university or hospital work. But, as I have said, the question of what becomes of the professor's fees seems to me of limited importance—a detail in connection with the larger problem. I can not see in it a great question of principle.

So far as the student goes, the danger that under the direction of a salaried professor, he may be given a training more purely academic and insufficiently practical seems to me small. In the first place, it has already been pointed out that the professor of medicine will doubtless be a man who has had a considerable clinical experience with patients in all classes of life, whose training has been by no means purely academic, and although some of his associates will perhaps be men who have not yet acquired the ripened experience which should be that of the head of the department, yet no one for a moment fancies that *all* the instruction in medicine and surgery will be given by the nucleus of teachers wholly dependent on their salaries. In every large clinic, and in every large hospital affiliated with a university, a considerable part of the instruction in general medicine and surgery, as well as in specialties, must be entrusted to men with or without salaries, who are more or less actively engaged in practise. The fancy that because the director of such a clinic and many of his assistants are no longer at the beck and call of the public, the student is to be regarded as deprived of the opportunities offered by association with men who have been or are engaged in active practise, is a misconception.

That which the reorganization of a clinic upon a university basis should do, however, is to bring it about that the practitioners who share in the work and advantages of the hospital and take part in the instruction may be rather more carefully and wisely chosen than they have been in the past. Well-digested experience, merit and teaching ability should more clearly and surely be recognized by a director untrammelled by hospital traditions and bent solely on the improvement of his clinic.

The experienced clinician who is still engaged in private or consulting practise, if he be a man of high order, is not likely to lose his touch with the hospital or with the clinic so long as he is able and desirous of giving it his services. Indeed, it is probable that in the future, institutions will retain a closer connection with some of the members of the staff who are engaged in private consulting practise by offering them the privileges of consulting rooms at the hospital. This plan, which has already been adopted in some instances, ought to be of great mutual advantage to hospital, to physician and to patient. To the hospital because it brings into close connection with the clinic those examples of rare and unusual disease which are sent to the consultant; to the physician because he is able to give much more time to his work at the hospital; to the patient because if the consulting room of the physician be at the hospital center, the many accessory examinations which so often have to be made, can be carried out much more expeditiously. But if such a physician be engaged in active consulting practise, he will no longer be the director of the clinic, and this, as has been pointed out, would seem to be desirable from every standpoint. For only under exceptional circumstances can such a man command the time necessary properly to direct a full department.

How much or how little time the head of a department of medicine or surgery may give to consulting practise is, however, a question which in the end must depend entirely on the character of the man. He may give very little of his time; he may give a good deal. But if he be a man

whose living interest is in his clinic, it matters little. For in either instance, through the character of the men that he associates with him, he will see that his department does its best work.

The objection so often raised that there is danger that a professor of medicine or surgery who abstains from outside consulting practise may be removed from touch with the profession, is comprehensible but not, I think, serious. If the director of the department be one who does a considerable amount of clinical work, he will still keep in active touch with the medical profession even though his consultations be held only at the hospital. In any event, the work of the department itself, set forth by him and by his associates and assistants in public clinics, in medical societies, and in journals, should keep him well before the eyes of the medical world.

The tendencies of the hour would seem to indicate that a very large nucleus of the staff of the medical or surgical clinic will in the future consist of salaried men who are giving the greater part of their time to the activities of the department; and it is very interesting that not only in hospitals affiliated with university schools of medicine, but in other independent institutions, this idea has already taken root. The experiment of a generously salaried staff of physicians and surgeons who are expected to give the greater part of their time, if not their entire time to the institution, is already being made in various hospitals.

One of the most important functions of a modern medical or surgical clinic is that it should afford opportunities for the ambitious student with scientific aspirations to pursue that course of study and acquire that experience which will fit him for a university career. Every year there graduate from our schools of medicine men with the ideals, aspirations and abilities of the true student, who, because of financial disability, are obliged to enter directly into active practise. A certain number of these men preserve their enthusiasm, make the most of their opportunities, and return later to the pursuit of those studies which have always been the object of their ambitions. Some find unexpected intellectual satisfaction in the varied opportunities offered by the life of a practitioner. Others, dazzled by the financial rewards of success, lose their early ideals. Many, however, are obliged to sacrifice their ambitions. With the organization of the modern medical clinic, there should be a considerable number of assistantships commanding salaries which should make it possible for many of the really good men to pursue their chosen career. And it is highly desirable that such salaries should be sufficient and so graded that these men may continue their work through long years should they prove themselves of suitable character and ability.

But—and this is a question very often raised—what about the opportunities for the development of practitioners or consultants if every medical or surgical clinic become a training school for professors of medicine? The answer is simple. The training which best fits a man for a professorship differs in no way from that which best qualifies him for the career of a practitioner or consultant. Some of the men who start upon their career in a modern department of medicine will remain connected with the service in one capacity or another for ten or fifteen years or even more, until the offer of a position as assistant or professor or director in another large clinic comes to them. Many, after eight or ten years' experience, will find themselves well fitted to enter into the practise of medicine or surgery as consultants. Others after spending a shorter period of time will doubtless take up general or special practise. That to which we

may look forward with reasonable certainty, however, is that the reorganization of hospital and university clinics according to this general plan, the essential feature of which is the establishment of a large nucleus of salaried men who give the greater part of their time to the activities of their service, will provide for university, hospital and public a body of men better trained, and with richer experience than has been offered in times past.

There is one point in connection with the reorganization of the clinic upon what I have called a university basis which seems to me of real importance. This has been touched upon especially by Dr. Meltzer.[2] I refer to the desirability of ample provision for voluntary assistantships. This is a matter which touches especially hospital organization. The work of a modern hospital clinic has changed greatly. A well-organized medical or surgical clinic is as truly a scientific department as are the university departments of anatomy, physiology and chemistry, and in every hospital there is a constant demand for more and more students to assist in the researches which are being conducted by the various subdepartments, and incidentally in the care of the patients. The great advantage to a hospital of the presence of students in its wards has often been pointed out. Such students form a corps of extra assistants who enable us to study and care for our patients much more intelligently.

But where can one find the director of a medical clinic who is not longing for the services of more young men, recent graduates with scientific aspirations, to assist him in the study of a variety of different problems? As it is to-day, only those men who can obtain salaried positions upon the staff or are of independent means can afford to give the time required for such studies. But many a student, upon his graduation, and during the several years that follow, would be more than willing to accept a position as voluntary assistant if he might be given a room and his lodging in the hospital. Every modern medical or surgical clinic should have a number of these positions open to such men as the professor may see fit to select. There could be no better investment for the hospital. Research assistants should be considered as essential to the welfare of the hospital as are the regular internes.

[2] SCIENCE, 1914, XL., 620-628.

These are the considerations that I have wished to bring before you to-day. They have to do with matters which are not without public significance.

The relations of the medical sciences to the commonwealth are of great intimacy and of vital importance.

Time was when the physician was called upon only to minister to his ill or wounded fellow. To-day he is something more than the healer and the binder of wounds. The advice of the medical scientist is sought in every sphere of human activity. It is he who is called upon to outline and direct those measures which protect our homes from epidemic, our cities from pestilence. It is he who has opened the wealth of the tropics to the safe exploitation of man; to him we must look for that counsel which shall preserve the efficiency of our armies in the field and of our cohorts of industry at home; which shall lessen the horrors of war and the dangers of peace.

No effort can be too great; no sacrifice too costly that may afford to the student of the medical sciences the most active stimuli, the best opportunities for training and for research. For in the training of the student of medicine is involved more closely than is generally realized, the prosperity and safety of our country.

WILLIAM SYDNEY THAYER

406 Cathedral St.,
BALTIMORE

THE WORK OF THE JEFFERSON PHYSICAL LABORATORY

A synopsis of all the scientific investigations which have been carried on in the Jefferson Laboratory since its foundation in 1884 is beyond the scope of a brief notice. On the other hand, it is impossible to give a picture of our activities without a review of an extent sufficient to include the beginnings of those researches which are still in progress. Fortunately, it will not be necessary to go into much detail of description, since the eleven volumes of our "Contributions" contain a full account of all the results which have been obtained in the last dozen years.

The fact that this laboratory is not dominated by the work of any one man has led to a breadth of field in investigation rarely found in other similar institutions. The very number and variety of subjects, however, makes it difficult for a single individual to give an adequate account of the work as a whole. I have been freed from this difficulty by my colleagues, Professors Hall, Sabine, Davis and Bridgman, who have been kind enough to edit the account of their own researches.

Professor Hall's research work for many years has had to do with the flow of electricity and of heat in metals. He has published, usually in cooperation with others, various papers on thermal conductivity, on the Thomson effect, and on the electromagnetic and the thermomagnetic transverse or longitudinal effects in iron. Of late he has been occupied especially with the theories of electric and of thermal conduction, and of thermoelectric action, in metals. On this subject he published a paper in 1914, reaching the conclusion that "free electrons" play a much smaller part in conduction than many have supposed, but have an important function in thermo-electric action. In 1915, he published in *Il Nuovo Cimento* a short paper suggesting that the positive *ions* in a metal, probably as numerous as the free electrons, may have much to do in the maintenance of an electric current. He is now engaged in developing this idea.

Professor Sabine is continuing his investigations in the varied problems of architectural acoustics. The results, so far published, are proving of value to architects in the correction of auditoriums and in their design in advance of construction. At present the experiments relate to the transmission of sound through the structure. While Professor Sabine has been working in one field he has stimulated a number of students in a variety of different subjects. Some of the researches for which he was originally responsible are still in progress; of these the work of Professor Bridgman and the investigations in the Schumann region will be mentioned in detail presently.

The work of Professor G. W. Pierce on high-tension currents was for many years carried on in this laboratory. It is, therefore, a great temptation to add interest to this notice by including an account of it here. However, as Professor Pierce is now under his own roof, it seems only fair to allow him to describe the activities of his own laboratory, should he care to do so, at some future time.

Notwithstanding that a large part of the time of Professor Duane is taken up at the Huntington Hospital by his work on the application of the radiations from radioactive substances to the treatment of cancer, he is a most active contributor to the research output of this laboratory. He has himself written several articles, theoretical and experimental, on the subject of X-rays, Radioactivity and Atomic Theory during the past year and he is at present directing the experiments of four students in the same fields.

The establishment of standards of wavelength and the study of the emission of gases and solids in the Schumann region has occupied me for the last fifteen years; recently I have succeeded in extending the spectrum, in the extreme ultra-violet, beyond the limit set by Schumann by an amount greater than that which Schumann achieved. There still remains, however, a considerable gap to be bridged before the region of the softest X-rays is reached. Researches on the abiotic action of Schumann rays and a study of the volume ionization produced by them, have been completed in years past by Dr. Bovie and Pro-

fessor Frederic Palmer. Researches on the photoelectric effect and on the reflection of metals in the extreme ultra-violet are now being conducted by Dr. Sabine and Dr. Gardner.

Professor Davis is chiefly occupied with thermodynamics, his work on the thermal properties of steam being somewhat widely known through Marks and Davis's "Steam Tables." At the present time he and Mr. Kleinschmidt, a research student, are setting up the necessary apparatus for reproducing the international temperature scale with great precision by means of resistance thermometers, in the hope of verifying and completing some work of Professor Richard's along that line. Four other students have carried on experimental work under his direction; Dr. Trueblood on the Joule-Thomson effect in superheated steam, Dr. Romberg on the specific heat of water, Mr. Royster on the Joule-Thomson effect in thermometric gases, and Mr. Loomis on the thermal properties of mercury vapor. The first two of these researches are nearly ready for publication; the last two are still in progress.

The work of Professor Bridgman is perhaps as well known as that of any member of our staff. I am indebted to him for the following summary: The thermodynamic properties of matter have been investigated under three main headings. The first heading has to do with the properties of liquids that do not freeze up to 12,000 kg. The chief results were these: nearly all the liquids show a reversal of dilatation at high pressure, the dilatation at the higher temperatures becoming less than at lower temperatures. Beyond a certain pressure, the repulsive forces between the molecules predominates over the attractive forces so that work is stored up as pressure is increased. All liquids show persistent individual variations, doubtless in some way connected with specific molecular properties. The second heading has to do with melting curves. By examination of some 20 liquids, the characteristics of their melting curves at high pressure have been established; neither of the two theories, formerly accepted as correct, is true. The melting curve neither ends in a critical point nor passes through a maximum, but continues to rise indefinitely, approaching a straight line at high pressure. The third heading has to do with polymorphic changes of solids. Some 150 substances have been examined and the phase diagrams of 30 substances have been studied and a number of new modifications have been found. The relations are most complicated and do not tend to any common type of behavior at high pressure. It is the rule that the phase of smaller volume is more compressible than the phase of greater volume and there are a number of cases in which the phase stable at higher pressures has a smaller specific heat. It can be definitely proved by these results that, at least in many cases, the centers of attractive force between the molecules are not located at their geometrical centers, but are probably close to the surface.

Dr. Chaffee's chief interests lie in the same field as those of Professor Pierce, but, as part of his work is still carried on in this building, it is fair to claim his study of oscillatory circuits as a product of this laboratory; as one result of this investigation he has perfected the "Chaffee Gap" a device of wide utility in wireless telegraphy.

Among the junior members of the teaching staff, Dr. D. L. Webster has recently turned his attention to the experimental study of characteristic X radiation; thanks to the generosity of the General Electric Company, and by the use of the laboratory's 40,000-volt storage battery, he has already obtained some important results from a rhodium target. Dr. Clark has been at work on the study of the vibrations in a stretched wire; he is at present engaged in the design and construction of a deep-sea thermometer. Dr. Nusbaum is engaged upon the study of hysteresis loss in iron at very high frequencies.

There are in all twelve candidates for the doctorate at present at work on pieces of research or on theoretical problems; the fields of study of five of these men have been already mentioned; of the other seven, four are working in spectroscopy, a subject for which we are

particularly well equipped, two are in electrodynamics and one in the study of viscosity of liquids.

The building in which all these researches are conducted is more than thirty-two years old, but, all things considered, it still serves its purpose very well. This is all the more remarkable when it is remembered that at the time when it was built there were few laboratories, either here or abroad, to serve as models. It is to the foresight of Professor John Trowbridge that the successful design of the Jefferson laboratory was largely due and it was his unselfish energy which made its equipment possible. Those who work in the building should ever keep these facts gratefully in mind.

Theodore Lyman

Cambridge

SCIENTIFIC NOTES AND NEWS

The Society of American Bacteriologists will meet at New Haven on December 26, 27 and 28. There will be an adjourned meeting in New York on December 29 in affiliation with Section K of the American Association. Members of program committee who have been requested, in opening the sessions under their charge, to review the work done in America in their field in bacteriology are as follows: Professor C.-E. A. Winslow, characterization and classification; Dr. F. G. Novy, protozoology; Professor C. E. Marshall, agricultural bacteriology; Professor F. P. Gorham, industrial bacteriology; Professor E. O. Jordan, sanitary bacteriology; Dr. W. H. Park, human pathology; Dr. V. A. Moore, comparative pathology; Dr. Erwin Smith, phytopathology, and Dr. D. H. Bergey, pedagogics of bacteriology. Those who have accepted invitations to speak at the dinner are Dr. A. C. Abbott, Dr. Herman M. Biggs, Professor H. W. Conn, Dr. J. J. Kinyoun, Professor W. T. Sedgwick, Dr. Theobald Smith, Dr. V. C. Vaughan and Dr. W. H. Welch.

To celebrate the eighty-sixth birthday (May 6) of Dr. Abraham Jacobi a dinner was given at the Ritz-Carlton, New York. Dr. Jacobi, emeritus professor of diseases of children in Columbia University, is in active hospital and private practise in New York City.

Dr. Raymond Dodge, professor of psychology in Wesleyan University, has been appointed by the trustees of Columbia University to be Ernest Kempton Adams research fellow for the academic year 1916–17.

At its meeting held May 10, 1916, the Rumford Committee of the American Academy of Arts and Sciences voted a grant of $500 to Professor R. A. Millikan, of the University of Chicago, in aid of his researches on the photoelectric properties of metals in extreme vacua.

A grant of $300 has been made from the C. M. Warren Fund of the American Academy of Arts and Sciences to Professor Grinnell Jones, of Harvard University, for work on the free energy of chemical reactions.

The British Institution of Civil Engineers has made the following awards for papers read and discussed during the session of 1915–16: A Telford gold medal to Sir John Benton (Eastbourne); a Watt gold medal to Sir George Buchanan (Rangoon); a George Stephenson gold medal to Mr. F. W. Carter (Rugby), and Telford premiums to Mr. C. Carkeet James (London), Mr. D. E. Lloyd-Davies (Cape Town), and Mr. W. T. Lucy (Oxford).

The two annual Walker prizes in Natural History offered by the Boston Society of Natural History were this year awarded as follows: a first prize of one hundred dollars to Wilbert Amie Clemens for his essay entitled "An Ecological Study of the May-fly, *Chirotenetes*," and a second prize of fifty dollars to Carl Cheswell Forsaith, for his essay on "The Relation of Peat Deposits to the Formation of Coal." These prizes are annually offered for the best memoirs submitted on subjects in natural history, and while the composition is open to all, it was the intent of the founder of the prizes, the late William Johnson Walker, that they should serve as an encouragement for younger naturalists, rather than as a reward for mature investigators.

DR. R. HAMLYN-HARRIS, director of the Queensland Museum, has been elected president of the Royal Society of Queensland.

PROFESSOR E. M. LEHNERTS, of the University of Minnesota, has succeeded D. Lange as president of the Minnesota Forestry Association.

DR. R. WILLSTÄTTER, professor of chemistry at Berlin, has been elected a foreign member of the Swedish Academy of Sciences.

DR. FREDERICK TAYLOR has been reelected president of the Royal College of Physicians, London.

DR. ARTHUR D. LITTLE, of Boston, has been placed in charge of the bureau, which was organized recently in Montreal for the purpose of coordinating the work of scientific men and experts engaged in scientific research in all parts of the Dominion of Canada.

DR. RALPH H. MCKEE has resigned his position as professor of chemistry in the University of Maine, to become head of the research department of the Tennessee Copper Company with laboratory headquarters at Ridgefield Park, N. J.

S. B. HASKELL has resigned as professor of agronomy in the Massachusetts College, to engage in commercial work.

CONTINUING the policy which has been in effect in Nela Research Laboratory for the past two summers, the following three men have accepted invitations to pursue research work in the laboratory during the coming summer: Professor Ulric Dahlgren, professor of biology, Princeton University; Dr. W. E. Burge, acting head of the department of physiology, University of Illinois, and Dr. Jakob Kunz, associate professor of physics, University of Illinois. Dr. Edward O. Hulburt, of the Johns Hopkins University, has been appointed Charles F. Brush fellow in physics in the laboratory for the summer of 1916.

ACCORDING to a press dispatch the British government has decided to organize an expedition for the relief of Sir Ernest Shackleton's Antarctic expedition.

PROFESSOR RICHARD P. STRONG, of Harvard University, who is a member of the Serbian Distress Fund Committee, is returning to Europe in a few days for the purpose of making arrangements for relieving the distress of native civilians, who have been unable to leave Serbia. A fund will be raised for this relief and also for that of the Serbians who have left.

THE third medical unit to be sent by Harvard to relieve the present university contingent in Europe will be composed of twenty-three surgeons, nearly all graduates of the Harvard Medical School. The unit, led by Dr. Hugh Cabot, '94, will sail for England on the Cunard liner, *Andania*, on May 20.

MESSRS. ALFRED H. BROOKS, SIDNEY PAIGE, H. G. FERGUSON and J. FRED HUNTER, JR., of the U. S. Geological Survey, have joined the military training camp to be held at Dodge, Ga., from May 3 to June 1.

PROFESSOR THEOBALD SMITH, of the Rockefeller Foundation for Medical Research, Princeton, New Jersey, will deliver the second Mellon lecture under the auspices of the Biological Society for Medical Research of the University of Pittsburgh, in the Mellon Institute for Industrial Research on May 17. The subject of the address will be "Certain Aspects of Natural and Acquired Resistance to Tuberculosis and their Bearing on Preventive Measures."

THE following addresses dealing with various phases of human and animal nutrition have recently been given before the Washington Academy of Sciences:

Dr. C. L. Alsberg, "The Biochemical Analysis of Nutrition."

Dr. Eugene F. Du Bois, "The Basal Food Requirement of Man."

Dr. Graham Lusk, "Nutrition and Food Economics."

Dr. E. B. Forbes, "Investigations on the Mineral Metabolism of Animals."

Dr. Carl Voegtlin, "The Relation of the Vitamines to Nutrition in Health and Disease."

The addresses will be published in the *Journal* of the Washington Academy of Sciences and reprinted in a collected form.

THE Scientific Association of the Johns Hopkins University was addressed on May 11

by Dr. Ira Remsen on "Chemistry and the Present War."

At the Case School of Applied Science, Dr. L. A. Bauer, of the Carnegie Institution of Washington, will, on May 23, give the lecture at the open meeting of the Society of Sigma Xi, his subject being "The Earth a Great Magnet and the Work of the Non-magnetic yacht *Carnegie*."

Professor Raymond Dodge, of Wesleyan University, spent the time from May 6 to 8 in consultation with the bureau of applied psychology at the Carnegie Institute of Technology, and delivered a lecture on "Some Psychological Effects of Alcohol."

Professor E. M. Freeman, assistant dean of the college of agriculture of the University of Minnesota, gave the Sigma Xi address at the University of Wisconsin on April 26. His subject was "Wheat Rust Investigations."

The Philadelphia Academy of Surgery announces that essays in competition for the Samuel D. Gross prize of $1,500 will be received until January 21, 1920. Full information may be obtained by writing to the trustees, 19 South Twenty-second Street, Philadelphia.

Sir Alexander R. Simpson, for many years professor of midwifery in the University of Edinburgh, bequeaths the museum formed by his uncle, the late Sir James Young Simpson, the discoverer of chloroform as an anesthetic, to the University of Edinburgh. He had previously given his uncle's and his own libraries to the Royal College of Physicians, Edinburgh.

The bronze tablet placed in St. Paul's Cathedral to the memory of Captain Scott and his companions was unveiled on May 5.

Professor I. P. B. Menschutkin, of the Polytechnic Institute, Petrograd, writing on March 20, informs *Nature* that Professor Pawlow is alive and well. The obituary notices which appeared in scientific and medical journals were, as has been suggested in Science, due to confusion with E. W. Pawlow, a Petrograd surgeon, who died in February.

John Edson Sweet, who was professor of practical mechanics at Cornell University from 1873 to 1879, died in Syracuse, N. Y., on May 8, aged eighty-four years.

William Stanley, known for his work in electrical engineering, died at Great Barrington, on May 14, in his forty-ninth year.

Dr. S. M. Brickner, known as a gynecologist and for his work in anatomy, physician at the Sloane Maternity Hospital and at the Mt. Sinai Hospital, until his retirement to Saranac Lake three years ago, died on May 5, at the age of forty-eight years.

Dr. Edward Leaming, formerly instructor in photomicrography in Columbia University, known for his contributions to this subject and the X-rays, died on May 11, aged fifty-four years.

Major W. L. Hawksley, health officer at Liverpool and known for his work on tuberculosis, has been killed while on active service in France.

The death is announced of Professor O. Maass, of the University of Munich, known for his experimental work on sponges.

Dr. Richard Braungart, professor of agriculture in the Bavarian Academy of Agriculture, has died at the age of seventy-seven years.

Mrs. Frances Thome, widow of the late director of the Argentine National Observatory at Cordoba, died recently in Buenos Aires. During over twenty years' residence at the observatory she took part in recording for the Durchmusterung, observing, and in various details of copying and preparation for the press of this work, and of the meridian results.

The London *Daily Chronicle* for April 24 as quoted in *Nature* gives the substance of a letter sent to Professor Lorentz, of Haarlem, by Dr. Max Planck, professor of mathematical physics in the University of Berlin, and permanent secretary of the Royal Prussian Academy of Sciences. In this letter Professor Planck recalls the letter addressed to the civilized world in August, 1914, by ninety-three German scholars and artists, in which they defended the conduct of their own government, and denounced in extravagant language

the action of the allies. Professor Planck himself was one of the signatories. He is now said to admit that the form in which this letter was written led to regrettable misunderstandings of the real sentiments of the signatories. In his opinion, and it is an opinion shared, he says, by his colleagues Harnack, Nernst, Waldeyer and Wilamowitz-Möllendorff, that letter of appeal was written and signed in the patriotic exuberance of the first weeks of the war. It must not be taken for granted, says Professor Planck, that at the present time anything like a scientific judgment can be formed with regard to the great questions of the historical present. "But what I wish to impress on you," he writes to Dr. Lorentz, "is that notwithstanding the awful events around us, I have come to the firm conviction that there are moral and intellectual regions which lie beyond this war of nations, and that honorable cooperation, the cultivation of international values, and personal respect for the citizens of an enemy state are perfectly compatible with glowing love and intense work for one's own country."

UNIVERSITY AND EDUCATIONAL NEWS

BY the will of Charles W. Harkness, who died on May 1, Yale University will receive \$500,000. There are also bequests to the Presbyterian Hospital of \$100,000 for endowment purposes, and \$250,000 to be added to the Harkness Fund for scientific and educational work.

A BEQUEST of \$150,000 has been made to the Johns Hopkins University by Miss Jessie Gillender for the purpose of instituting organized research into the problem of epilepsy.

THE Long Island College Hospital, Brooklyn, announces that after January 1, 1918, the completion of two years of study in a college of liberal arts or science will be required for admission to the four-year medical course leading to the degree of M.D. At present the requirement is one year only of college work. Beginning in the fall of 1916 Columbia University, New York, will conduct a pre-medical college year at the Long Island College Hospital.

MR. ARTHUR DU CROS, M.P. for Hastings, has promised a gift of £7,000 to the extension fund of the London School of Medicine for Women, thus completing the £30,000 for which appeal was made.

CLYDE BROOKS, A.B., Ph.D., M.D., has resigned his post at the University of Pittsburgh Medical School and has accepted the position of professor and head of the department of physiology, pharmacology and physiological chemistry in the school of medicine of the University of Ohio, at Columbus, Ohio. This marks the beginning of a plan to be carried out by the newly elected dean, Dr. E. F. McCampbell, in reorganizing and developing the medical school at Columbus. The plan includes the erection of a new university hospital and a new medical building on the university campus.

AT Harvard University the following appointments to the staff of the medical school have been made: Ernest E. Tyzzer, to the George Fabyan professorship of comparative pathology; Charles J. White, to the Edward Wigglesworth professorship of dermatology, and Arthur D. Hill, to a professorship of law. Percy G. Stiles has been promoted to be assistant professor of physiology, and Dr. James H. Wright, assistant professor of pathology.

AMONG the new appointments at the University of Chicago is that of George Van Biesbroeck, adjunct astronomer of the Royal Observatory of Belgium, as professor of practical astronomy at Yerkes Observatory. Promotions include the following: To a professorship: Henry Gordon Gale, of the department of physics. To associate professorships: Harvey Carr, of the department of psychology, and Preston Kyes, of the department of anatomy. To assistant professorships: Joseph W. Hayes, of the department of psychology, and Wellington D. Jones, of the department of geography.

IN the department of zoology of Columbia University, Dr. William K. Gregory, now associate, has been promoted to be assistant pro-

fessor of vertebrate paleontology. He will retain his position at the American Museum of Natural History.

Professor Ernst Gaupp, of Königsberg, has accepted a call to the chair of anatomy at Breslau.

DISCUSSION AND CORRESPONDENCE

AGE OF THE TUXPAM BEDS

In Science of February 10, 1911, the writer gave a preliminary sketch of the Tertiary deposits of northeastern Mexico. In this communication the beds occurring in the vicinity of Tuxpam with their wealth of fossils, which appeared to be largely new or undescribed species, were stated to probably belong to the Miocene, and this reference has been followed in later publications both by himself and by others.

While both gasteropods and bivalves were abundant at this locality, the most characteristic fossils of these beds were the echinoderms, which included great numbers of a very large *Clypeaster,* one or more species of *Schizodus, Macropneustes* and *Cidaris.* None of these special forms were reported by other observers from the region to the south of Tecolutla, but the similarity of the deposits of the lower coastal area seemed to indicate their continuity, and since such fossils as had been described from these continuations were considered of Miocene or Pliocene age, it seemed probable that the Tuxpam beds were also of that age.

During the examinations made in the coastal area between Tuxpam and Tampico since this publication, numerous collections of fossils have been made and these are now being examined. We find that the Tuxpam *Clypeaster, Cidaris* and *Macropneustes* occur elsewhere in connection with the nummulites, cristillaria and orbitoides of the Oligocene, but where we find this association we do not find the large number of gasteropods and bivalves which are found at Tuxpam, or on the San Fernando. The shells usually accompanying these echinoderms around Tampico are simply a small pecten, a nucula, and one or two small gasteropods. In some localities imprints of leaves are abundant in the accompanying shales.

Such an association of fossils seems to require the reference of the Tuxpam beds to the Oligocene, and if this be true, it would appear that along the western gulf shore there is no marine Miocene on the surface between Tuxpam and Galveston.

E. T. Dumble

NITER SPOTS

To the Editor of Science: In a recent number of Science[1] is to be found an article by Sackett and Isham relating to the formation of "niter spots" in the arid regions of the western United States. In a more recent number of the same magazine[2] Stewart and Peterson have given a lengthy and interesting discussion of this paper and also a description of these brown spots. These later writers have attributed the origin of these nitrates to the leaching and concentrating action of irrigating water upon the nitrates occurring in the shales and sandstones (or country rock) adjacent to and underneath the affected areas from which the soil has been derived. Their field observations were in Utah, where they describe the appearance of brown "niter spots" in certain irrigated fields.

While making some geological investigations in northwestern Nevada in 1912 it was the present writer's pleasure to make some notes relating to brown "niter spots" occurring on the playas. The observations being in strict conformity with well-known principles of commercial niter formation, the necessity of much speculation before arriving at a conclusion as to their origin was obviated. It is trusted that the few simple facts recorded at that time will serve in giving some added light on the subject in hand.

In traversing the playas brown spots were frequently noted on the surface in connection with alkali salts. When the brown mixtures of earth and salts were tested they invariably showed large amounts of nitrates. In places on the surface where the brown color was not present no nitrates were noted. Pits dug failed to show nitrates at greater depths than

[1] N. S., Vol. XLII., p. 452.

[2] N. S., Vol. XLIII., pp. 20–24.

two to three inches beneath the surface. Jack rabbits inhabited the areas in great numbers and it was first observed that wherever alkaline waters had come in contact with their feces the water, which usually held in small puddles, took on a dark brown color not unlike that of the waters holding in many unclean barnyards after a rainstorm. The decomposition of the fecal matter appeared to be comparatively rapid when in contact with the alkaline waters or with the moist alkali soil and air. The animal refuse was observed in all stages of decomposition from the fresh droppings to the complete disappearance of the original organic material. With the evaporation of the waters which had been in contact with this refuse the soil took on the brown color noted and responded to tests for nitrates. Fecal matter from cattle and horses was later observed undergoing the same type of decomposition and producing similar brown spots containing nitrates. All of the water on the playas examined was of an alkaline nature.

Since these observations are in harmony with the established principles of niter formation in India there was no hesitation in concluding that the brown "niter spots" of the playas were, as far as examined, of animal origin.

From these Nevada observations it is safe to predict that in fields of the arid western states brown "niter spots" will appear when live stock is pastured in the same and alkaline waters are used for irrigation. In this connection it would be important to know if live stock was pastured in the fields in which Stewart and Peterson made their observations. This fact would seemingly have an important bearing on their conclusions.

Walter Stalder

San Francisco, Calif.

SCIENTIFIC BOOKS

Historical Introduction to Mathematical Literature. By G. A. Miller, Professor of Mathematics in the University of Illinois. New York, The Macmillan Co., 1916. Pp. xiii + 302.

This valuable work is decidedly unique. It is not a history of mathematics, yet contains much accurate historical information. It is not a bibliography of mathematics, yet it says much about books, journals and dictionaries. It is not a volume on mathematical recreations, yet is most interesting reading. It is not a philosophy of mathematics, though it illumines such matters as Betrand Russell's definition of mathematics as "the subject in which we never know what we are talking about nor whether what we are saying is true." It is not a collection of biographies, though brief sketches of twenty-five leading mathematicians are given in one of the chapters. The book gives much miscellaneous information on recent mathematical activity in different countries of the world. The organization of mathematical societies, the starting of mathematical journals, the trend of modern thought along the lines of arithmetic, algebra, geometry and analysis, are all presented in a popular and pleasing manner, by one who is able to take a broad view of the mathematics of to-day. Attention is given to topics of general interest, such as Fermat's last theorem, magic squares, systems of numeral notation, women mathematicians, the international commission on the teaching of mathematics. The purposes of the book, as expressed in the words of the author, are "to meet the needs of a text-book for synoptic and inspirational courses which can be followed successfully by those who have not had extensive mathematical training. It may also be used as a text-book for a first course in the history of mathematics, especially by those teachers who believe with its author that such a first course should largely concern itself with recent mathematical events and developments." This aim is achieved in an eminently satisfactory manner. The book meets a real want.

The list of books on the history and the teaching of mathematics, recommended by the author, is selected more particularly to meet the needs of English readers. This list makes it painfully conspicuous that there are at present no up-to-date general histories of mathematics in the English language. The best general histories are in the German language. In

recent years much criticism has been passed upon Moritz Cantor's monumental work, written in German, yet nothing approaching it exists in the English language. Cantor is now in his eighty-seventh year and is nearly blind. If the revisions of his volumes which were planned before the war, and were to be executed by younger men, are carried out, then his history will doubtless maintain an undisputed supremacy for many years to come. Professor Miller says that Tropfke's work is "getting too old to be entirely reliable." Tropfke himself stated last spring to the present writer that his history needed revision. But Miller's criticism on Tropfke's history applies with even greater force to the general histories written in the English language.

FLORIAN CAJORI

COLORADO COLLEGE,
COLORADO SPRINGS, COLO.

Dyestuffs and Coal Tar Products. Their Chemistry, Manufacture and Application. By THOMAS BEACALL, B.A., F. CHALLENGER, Ph.D., B.Sc., GEOFFREY MARTIN, Ph.D., M.Sc., B.Sc., and HENRY J. S. SAND, D.Sc., Ph.D. Pub. D. Appleton and Co. 8vo. 156 pages, 29 fig.

The critical situation which developed in the textile, leather and other industries on account of the shortage of dyes, as well as in the pharmaceutical and photographic trades on account of a similar shortage of synthetic drugs and organic chemicals was largely responsible for the publication of this book. It is virtually a reprint with certain revisions and additions of chapters from "Industrial and Manufacturing Chemistry," Vol. 1, edited by Geoffrey Martin, on the following subjects:

"Industry of Coal Tar and Coal Tar Products."
"Industry of the Synthetic Coloring Matters."
"Industry of Natural Dyestuffs."
"The Dyeing and Color-Printing Industry."
"Modern Inks."
"Saccharine and other Sweetening Chemicals."
"The Industry of Modern Synthetic Drugs."
"The Industry of Photographic Chemicals."

The field covered is so broad and presents such extreme possibilities of theoretical and practical details that the present publication can only be looked upon as a résumé. To those having a knowledge of organic chemistry a study of the book will serve as a valuable review and a foundation for further study. A valuable feature of the book is the bibliography at the introduction of each chapter.

L. A. OLNEY

LOWELL TEXTILE SCHOOL,
LOWELL, MASS.

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE third number of volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *The Mechanics of Intrusion of the Black Hills (S. D.) Pre-Cambrian Granite:* SIDNEY PAIGE, U. S. Geological Survey, Washington, D. C.

2. *On the Fossil Algae of the Petroleum-Yielding Shales of the Green River Formation of Colorado and Utah:* CHARLES A. DAVIS, Bureau of Mines, Washington, D. C.

Scientific, as well as economic interest has been aroused in these shales, because they have recently been discovered to yield petroleum when subjected to destructive distillation in closed retorts. The author finds that these shales may be examined microscopically by the methods of sectioning already in use for peats and coals.

3. *Archeological Explorations at Pecos, New Mexico:* A. V. KIDDER, Department of Archæology, Phillips Andover Academy.

The most important results are stratigraphical; various styles of pottery being found in superposition.

4. *Man and Metals:* WALTER HOUGH, U. S. National Museum, Washington, D. C.

An account is given of the author's study of the uses of fire by man in so far as the development of metallurgy is concerned.

5. *On the Observed Rotations of a Planetary Nebula:* W. W. CAMPBELL and J. H. MOORE, Lick Observatory, University of California.

The nebula No. 7009 of Dreyer's New General Catalogue is rotating about an axis

through the central nucleus nearly at right angles to the plane passing through the observer and the major axis of the image. The mass of the nebulæ is apparently several times larger than that of the sun. It is suggested that the ring nebulæ are not true rings, but ellipsoidal shells.

6. *A Short Period Cepheid with Variable Spectrum:* HARLOW SHAPLEY, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The star *RR* Lyræ is a periodic variable in at least three ways: first, in the light intensity; second, in the radial velocity; and third, in the spectrum which changes from F to A. A similar spectral change is found in *RS* Boötis.

7. *The Spectrum of δ Cephei:* WALTER S. ADAMS and HARLOW SHAPLEY, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

At maximum the high temperature lines are very strong and the low temperature lines very weak; while at the minimum the reverse is the case. This indicates that at maximum the temperature of the gases of the star's absorbing envelope is higher than at minimum.

8. *Investigations in Stellar Spectroscopy. I. A Quantitative Method of Classifying Stellar Spectra:* WALTER S. ADAMS, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Method replaces to a considerable extent direct estimations of spectral type by numerical estimates of relative line intensity which may be made with much higher accuracy.

9. *Investigations in Stellar Spectroscopy. II. A Spectroscopic Method of Determining Stellar Parallaxes. III. Application of a Spectroscopic Method of Determining Stellar Distances to Stars of Measured Parallax:* WALTER S. ADAMS, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The method of computing absolute magnitudes and parallaxes from the variation of the intensities of lines in the stellar spectrum is capable of yielding results of a very considerable degree of accuracy.

10. *Investigations in Stellar Spectroscopy. IV. Spectroscopic Evidence for the Existence of Two Classes of M Type Stars:* WALTER S. ADAMS, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Two groups of M stars are indicated clearly by examination of the intensities of the hydrogen lines.

11. *The Failure and Revival of the Process of Pigmentation in the Human Skin:* A. E. JENKS, Department of Sociology and Anthropology, University of Minnesota.

It is found that on the one hand, there is an extension of the albinistic areas and on the other a revival of the process of pigment metabolism within an at-one-time albinistic area.

12. *Banded Glacial Slates of Permo-Carboniferous Age, showing possible Seasonal Variations in Deposition:* ROBERT W. SAYLES, University Museum, Harvard University.

A study of the slate and tillite formations of Squantum (near Boston) affords evidence of seasonal changes in the locality, indicating that it was in a temperate zone during Permian times as now.

13. *An Extension of Feuerbach's Theorem:* F. MORLEY, Johns Hopkins University.

All circular line-cubics on the joins of four orthocentric points touch the Feuerbach circle.

14. *Deformations of Transformations of Ribaucour:* L. P. EISENHART, Department of Mathematics, Princeton University.

15. *Geographic History of the San Juan Mountains since the Close of the Mesozoic Era:* WALLACE W. ATWOOD and KIRTLEY F. MATHER, Geological Museum, Harvard University.

The study of the geography of this region is closely related to the geologic studies of the range, but may lead also to a study of anthropogeography.

16. *The Age of the Middle Atlantic Coast Upper Cretaceous Deposits:* W. B. CLARK,

E. W. Berry and J. A. Gardner, Geological Laboratory, Johns Hopkins University.

The several Upper Cretaceous formations of the Middle Atlantic Coast represent all of the major divisions of the European series.

17. *Upper Cretaceous Floras of the World:* Edward W. Berry, Geological Laboratory, Johns Hopkins University.

The stratigraphic position of the more important of the Upper Cretaceous floras is indicated by a diagram.

18. *Observations on Amœba Feeding on Infusoria, and their Bearing on the Surface-Tension Theory:* S. O. Mast and F. M. Root, Zoological Laboratory, Johns Hopkins University.

Surface-tension is probably only a small factor in the process of feeding in Amœba.

19. *The Electromotive Force produced by the Acceleration of Metals:* Richard C. Tolman and T. Dale Stewart, Department of Chemistry, University of California.

Successful attempts have been made to change the relative position of positive and negative electricity in a piece of metal by subjecting it to a large retardation.

Edwin B. Wilson

Mass. Institute of Technology,
Boston, Mass.

SPECIAL ARTICLES

THE KATA THERMOMETER AS A MEASURE OF THE EFFECT OF ATMOSPHERIC CONDITIONS UPON BODILY COMFORT

It has been clearly demonstrated by numerous investigations that the objectionable effects of the air of a badly ventilated room are chiefly thermal rather than chemical in nature. At the same time it has been recognized that the ordinary thermometer is a very inadequate measure of the discomfort experienced in such a room because the heat loss from the body surface is influenced not only by the temperature of the surrounding air but also by the humidity present and the radiant heat which reaches the body, and above all by the movement of the air. The condition in a close room has been commonly compared with that which obtains outdoors on a muggy day in summer; yet it is clear that the outdoor temperature must be very much higher than the indoor temperature in order to produce a comparable degree of discomfort.

Dr. W. Heberden[1] pointed out these facts nearly a hundred years ago and suggested a way out of the difficulty by the observation of the rate of fall of a thermometer previously heated to a high temperature. He heated a thermometer to 100° F. and noted the number of degrees which it fell in ten minutes as a measure of "sensible cold." He records drops of from 8° to 22° in the first ten minutes.

The same device has recently been independently worked out by Dr. Leonard Hill in England[2] and the apparatus is now sold by Siebe Gorman and Company of Chicago under the name of the Kata thermometer.

The Kata thermometer outfit consists of two specially constructed thermometers with large bulbs and stems graduated from 86° to 110° F., one to be used as a dry and the other as a wet bulb thermometer. The bulbs are heated to about 110° and then placed in clips which hold them in a horizontal position, after drying the bare bulb on a clean cloth and jerking excess moisture off the silk covered one. The time taken to fall from 100° to 90° is then noted, best by the use of a stop-watch.

The rate of fall of both thermometers will obviously be affected by air movement and radiant heat as well as by air temperature, and that of the wet bulb by the humidity of the air as well. Dr. Hill believes that the combined influence of these factors will affect the Kata thermometers very much as it does the human body, and suggests a one-minute period for the wet bulb and a three-minute period for the dry bulb as upper limits for comfortable atmospheric conditions.

This instrument promises to be of so much assistance in the practical study of ventilation

1 "An Account of the Heat of July, 1825; together with Some Remarks upon Sensible Cold," *Trans. Roy. Soc.*, London, 1826, Part II., p. 69.

2 "The Physiology of the Open-Air Treatment," *The Lancet*, CLXXXIV., May 10, 1913, p. 1,283; see also O. W. Griffith, "Ventilation and Housing," *The Medical Officer*, XIII., June 19, 1915, p. 273.

problems that I have made a number of observations to determine how closely its records correspond with sensations of bodily comfort. These observations are presented in Tables I., II. and III. The first series was made indoors and outdoors in the country at Ipswich, Mass., during the month of August; the second in my laboratory at the American Museum of Natural History in New York (with and without the air current from a desk fan); and the

TABLE I[3]

Observation	Date	Shade Temperature	Kata Times, Seconds. Dry Bulb	Wet Bulb	Comfort Vote[4]	Remarks
1	7/8	73°	118	44	2.5	Porch, under awning. Light wind.
2	7/8	73°	237	55	3.5	Same as 1 but in direct sun.
3	7/8	77°	216	90	3.8	Indoors, table, under lamp.
4	8/8	68°	82	36	2.0	Porch. Cloudy day. Moderate wind.
5	10/8	75°	128	50	3.0	Porch, in shade of house. Clear, after rain. Light breeze.
6	10/8	75°	268	42	3.8	Same as 5 but in sun. More breeze.
7	11/8	74°	227	72	3.0	Indoors. Draft from open door.
8	13/8	75°	196	67	3.7	Porch. Cloudy. Air very damp. Light wind.
9	13/8	75°	105	43	2.7	Same as 8 but at end of porch in stronger breeze.
10	14/8	79°	188	48	3.4	Porch in shade. Moderate breeze.
11	14/8	80°	255	80	4.0	Same as 10 but out of wind.
12	16/8	82°	180	42	3.7	Porch in shade. Light wind.
13	17/8	72°	115	23	2.2	Porch in shade. Strong breeze.
14	21/8	77°	143	48	3.6	Porch in shade. Light breeze.
15	21/8	77°	159	37	3.4	Same as 14. Porch in sun. Sky clouded. More breeze.
16	22/8	89°	49	25	2.0	Porch. Cloudy day. High wind.
17	23/8	79°	320	94	4.7	Indoors. Five people and lamp in room.
18	29/8	66°	176	67	2.2	Indoors. Closed room. Rain outside.
19	29/8	72°	277	78	3.6	Indoors. Before fire.

[3] Observations made during month of August, 1915, at Ipswich, Mass.

[4] Average of vote of three to six observers, including four women, ages 90, 65, 38 and 36 and two men, ages 38 and 75.

TABLE II[5]

Observation	Date	Shade Temperature	Kata Times, Seconds Dry Bulb	Wet Bulb	Comfort Vote[6]	Fan[7]
20	1/9	71°	177	68	3.2	——
21	Do.	70°	78	25	2.6	First speed.
22	3/9	79°	355	95	3.7	——
23	Do.	79°	118	29	2.7	Half speed.
24	15/9	88°	720	148	4.8	——
25	Do.	87°	215	50	4.0	Half speed.
26	Do.	87°	223	45	3.8	Over third speed.
27	17/9	88°	844	131	4.5	——
28	Do.	88°	260	41	4.0	Half speed.
29	23/9	72°	233	69	3.8	——
30	Do.	72°	72	25	2.8	Half speed.
31	28/9	69°	200	71	3.4	——
32	Do.	69°	71	22	2.6	Half speed.
33	29/9	72°	220	62	3.2	——
34	Do.	72°	84	28	2.7	Half speed.
35	6/10	72°	240	75	3.6	——
36	Do.	72°	72	28	2.6	Half speed.

TABLE III[8]

Observation	Date	Shade Temperature	Kata Times, Seconds Dry Bulb	Wet Bulb	Comfort Vote[9]	Remarks
37	22/10	66°	200	62	3.1	One window open. Sun shining.
38	Do.	67°	181	52	3.0	Later. Windows closed. Sun clouded. Fan on.[10]
39	2/11	61°	122	48	2.2	Windows closed. Fan on.
40	5/11	61°	151	52	3.0	Windows closed. Fan on.
41	5/11	64°	148	49	2.9	Later. Fan off.
42	12/11	65°	159	55	3.2	Windows closed. Fan on.
43	12/11	67°	185	64	3.1	Later. Fan off.
44	26/11	69°	170	58	3.4	Windows closed. Fan on.
45	26/11	71°	196	51	3.4	Later. Fan off.

[5] Observations made in laboratory of Department of Public Health, American Museum of Natural History, New York, September and October, 1915.

[6] Average of vote of 3 to 6 observers, all males from 16 to 38 years of age.

[7] First observation on each date made in laboratory with windows closed. Second (and third of September 15) under same conditions but with a 15-inch colonial desk fan operating about 4 feet from thermometers and directed toward them.

[8] Observations made in physiological laboratory, Yale Medical School, through courtesy of Professor Yandell Henderson.

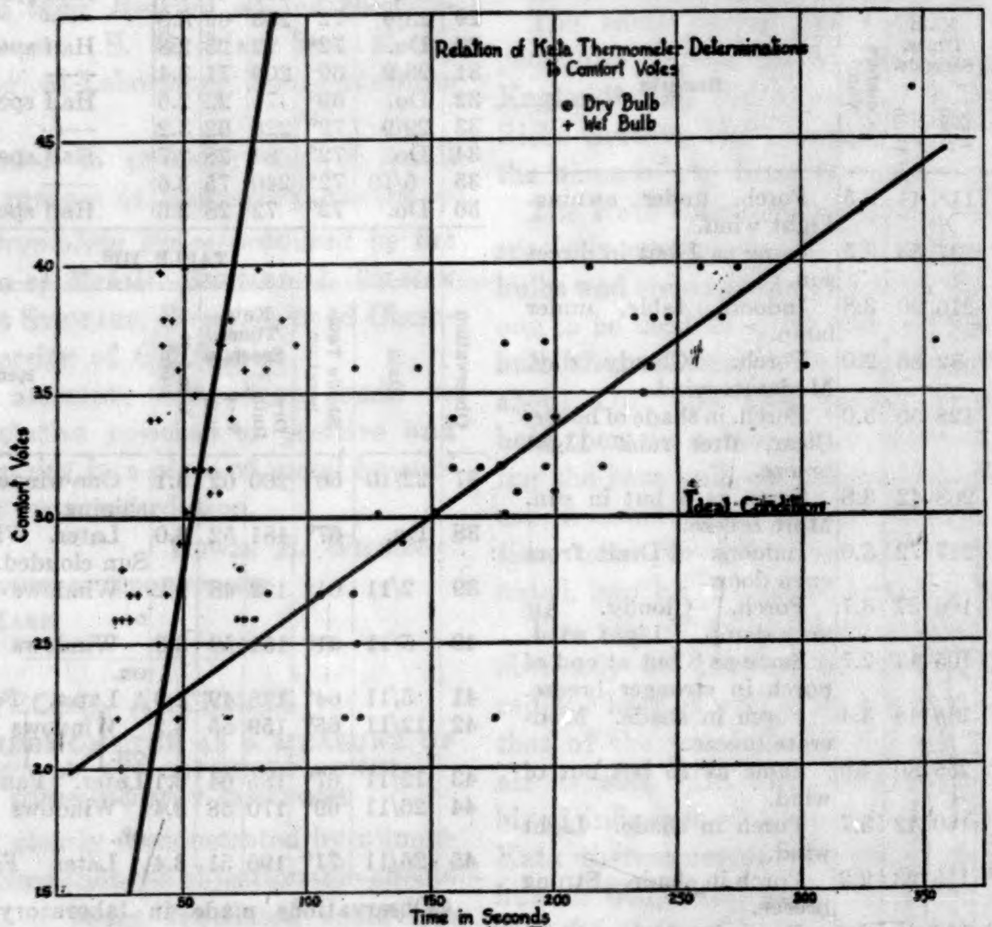
[9] Average of vote of 10 to 20 medical students.

[10] 22-inch exhaust fan in corner of ceiling.

third series in the physiological laboratory of the Yale Medical School, through the courtesy of Professor Yandell Henderson.

At the time each observation was made, from three to twenty observers were asked to express their opinion as to the comfortableness of the atmospheric conditions on a scale of five as follows: 1, cold; 2, cool; 3, ideal; 4, warm; 5, hot. The comfort vote in the table represents the average of the observers voting on each occasion.

With these exceptions the plotted points are not at all badly grouped about the calculated line, considering that we are dealing with so variable a factor as the sensation of comfort. A study of individual points which deviate widely from the straight line shows that of twelve cases in which the atmospheric conditions were voted as hotter than would be expected from the thermometer readings, every one was either outdoors in a wind or indoors in front of the electric fan (observations 6, 8, 10,



The results of the comfort vote have been plotted against wet and dry bulb readings in the diagram, the straight lines representing the most probable curve as calculated from individual observations. Two records out of the forty-five (Nos. 24 and 27) have been omitted since these very high values (12 minutes and 14 minutes, respectively, for the dry bulb) fell far below the curve. The comfort vote fails to express such extreme conditions adequately.

12, 14, 15, 21, 25, 26, 28, 30, 32). Of thirteen cases in which the atmospheric conditions were voted cooler than would be expected from the reading, on the other hand, only four were cases in which there was a strong current of moving air (observations 1, 3, 4, 7, 13, 16, 18, 19, 22, 33, 37, 38, 39). This probably means that whereas the ordinary thermometer leaves out entirely the effect of air movement, the Kata thermometer emphasizes it somewhat unduly.

On the whole, however, it seems clear that this instrument is of great value in measuring the actual influence of air conditions upon the body and is greatly superior to the ordinary thermometer for this purpose. Compare for instance observations 8 and 9, both made outdoors on a cloudy day, with an air temperature of 75°. In 8 the Kata thermometers and the observers were protected from the wind, while in 9 they were at the end of the porch in a breeze. The dry bulb times at these two points were 196 seconds and 105 seconds, respectively, and the comfort votes 3.7 and 2.7. In the first case it was uncomfortably warm, in the second too cool, with nothing in the reading of the ordinary thermometer to indicate any change. Again contrast observations 13 and 19, the first taken out of doors in a strong breeze, the second indoors before a fire. The ordinary thermometer registered 72° in each case, but in one instance the time for the fall of the Kata dry bulb was 115 seconds and the comfort vote 2.2; in the other case the dry bulb time was 277 seconds and the comfort vote 3.6. Out door conditions with ordinary thermometer readings of 75° (Nos. 5 and 9), 77° (No. 15), and 79° (No. 10) were more comfortable and showed lower Kata thermometer times than this room with a fire at 72°.

Most significant are the readings and the comfort votes in Table II., in which on each day conditions were noted, first without, and then with, the direct draft from an electric fan. In each case the ordinary thermometer either remained unchanged (or dropped one degree in two instances) while the Kata times and the comfort votes fell off enormously. On six different days, with ordinary thermometer readings varying from 69° to 79°, the comfort vote showed uncomfortably hot conditions and Kata dry bulb times over 170 without the fan and too cool conditions, and Kata dry bulb times under 120 with the fan turned on (observations 20–23 and 29–36). Even the condition of 87° on the ordinary thermometer (observation 26) was as comfortable and showed about the same Kata thermometer readings as were obtained without the fan at an air temperature of 72° (observation 29).

The curves as plotted suggest that the optimum for comfort (represented by an average vote of 3.0) falls close to the lower of the points suggested by Dr. Hill (45–60 seconds for the wet bulb and 150–180 seconds for the dry bulb). Too much stress can not of course be laid on a small number of observations such as are here reported, but the general value of the Kata thermometer seems sufficiently obvious to warrant its general use in the study of atmospheric conditions as they affect bodily comfort.[11]

C.-E. A. WINSLOW

YALE MEDICAL SCHOOL

THE AMERICAN PHILOSOPHICAL SOCIETY

THE general annual meeting of the American Philosophical Society was held on April 13, 14 and 15 during which nearly fifty papers were presented on a great variety of topics. The address of welcome was made by Dr. W. W. Keen, the president, who, with vice-presidents W. B. Scott and E. C. Pickering, presided at the various sessions.

On Friday evening a reception was held at the hall of the Historical Society of Pennsylvania, after which Dr. L. O. Howard, of Washington, gave a lecture "On Some Disease-bearing Insects."

Saturday afternoon was entirely devoted to a symposium on international law in its various aspects, five papers being presented.

The program and some abstracts of the papers follow:

THURSDAY, APRIL 13

Opening Session—2 o'clock

William W. Keen, M.D., LL.D., President, in the Chair

The Popes and the Crusades: DANA C. MUNRO.

The Common Folk of Shakespeare: FELIX E. SCHELLING.

A Rare Old-Slavonic Missal: J. DYNELEY PRINCE.

On the Art of Entering Another's Body: A Theme of Hindu Fiction: MAURICE BLOOMFIELD.

[11] Hill, Griffith, and Flack (*Phil. Trans. Roy. Soc. Lond.*, series *B*, Vol. 207, pp. 183–220) have recently published an important study in which the Kata readings are translated into fundamental physical units of millicalories of heat loss per square centimeter per second.

The Isles of the Blest: Paul Haupt.

The Interpretation of Mythology: Franz Boas.

America's Relation to the Developments of International Law: Leo S. Rowe.

Sight and Signaling in the Navy: Alexander Duane. (Introduced by Dr. Geo. E. de Schweinitz.)

Observations of the Mentality of Chimpanzees and Orangutans. (Illustrated with motion pictures.) William H. Furness, 3d.

THURSDAY EVENING, APRIL 13

Meeting of the officers and council at 8:30 o'clock.

FRIDAY, APRIL 14

Executive Session—9:30 o'clock

Proceedings of the officers and council submitted.

Morning Session—9:35 o'clock

William B. Scott, Sc.D., LL.D., Vice-president, in the Chair

Two New Terms, Cormophytaster and Xeniophyte, Axiomatically Fundamental in Botany: William Trelease.

Origin and Vegetation of Salt Marsh Pools: John W. Harshberger.

The Work of the Mellon Institute in its Relations to the Industries and to the Universities: Raymond F. Bacon.

The F_2 Generations, and Back-, and Inter-crosses of the F_1 Hybrids between Œnothera nutans and pycnocarpa: George F. Atkinson.

In the F_1 generation of the cross *Œnothera nutans* × *Œ. pycnocarpa* there appear four hybrid types, *Œ. nutella, Œ. pycnella, Œ. tortuosa* and *Œ. tortuella.* In the F_1 of the reciprocal cross three hybrid types have thus far appeared which are identical with three of the types named, viz., *nutella, pycnella* and *tortuella.* It is probable that if the number of individuals was very large, *tortuosa* would also appear.

Of these four F_1 hybrid types, *nutella* is a blend, and thus far has proved absolutely self-sterile, though the pollen works on *pycnella* and *tortuosa* (it has not been tried on *tortuella,* on both of the parents, and on all other species of *Œnothera* on which it has been tried. The egg cells are also fertile in reciprocal crosses with the same forms. *Pycnella, tortuosa* and *tortuella* are, on the other hand, "segregate" hybrids; *i. e.,* they select certain characters from each parent and develop them to their full expression. *Pycnella* and *tortuosa* are "counterparts," *i. e.,* the two together use all the characters of both parents, the one making use of the characters which the other omits. *Tortuella* appears to have all the characters of *tortuosa* except the red stem which comes from the parent *nutans, tortuella* having the green stem of the parent *pycnocarpa,* which is also inherited by *pycnella.* The hybrids *pycnella* and *tortuosa* are fixed in the F_1 generation, they breed true in the F_2 generation (*pycnella* has been tried in the F_3 and breeds true). *Tortuella,* however, appears to split in the F_2 generation. This result is remarkable that in the F_1 generation from a cross between two feral, non-mutating species, quadruplet hybrids appear in the F_1 generation; one is a blend and self-sterile, but its pollen and egg cells are fertile; two of the segregates are fixed types and breed true, while the fourth hybrid (3d segregate) appears to split in the second generation. The back- and inter-crosses show, either striking examples of patrocliny, or splitting into two types in some cases, into three types in other cases. But no new types (with a single exception) appear, they all conform to one or other of the six types, the primary parental types, or one or more of the F_1 hybrid types. The single exception is a mutant of the dwarf *gracilis* type.

Inheritance through Spores: John M. Coulter.

The current work in plant genetics suggests the question of the most favorable material. In the main, the most complex plants have been used, so that it is impossible to analyze the factors involved. Even the origin of the embryo is not always assured, on account of the frequent occurrence of apogamy. Furthermore, only inheritance through sexual reduction is secured. If sexual forms are desirable, it seems obvious that the most primitive ones should be included in experimental material, since in such forms the sex act is not involved with other structures, the origin of the sexual cells is observable, and the whole situation lends itself to more complete control and analysis. The sexual cells, however, are genetically related to spores, so that the origin of spores and their behavior in reproduction is preliminary to the origin of gametes and sexual reproduction. Reproduction spores, therefore, is a field rich in experimental possibilities. Analysis of the conditions of spore formation furnishes a clue to the additional conditions necessary for gamete formation; experimental modification of the "germ plasm" is more simple and definite than in com-

plex material; and breeding from spores with essentially pure lines is especially favorable for securing more definite data in reference to the possibilities of variation and inheritance.

The Dynamics of Antagonism: W. J. V. OSTERHOUT.

If two toxic substances antagonize each other we call this action antagonism. An accurate measure of antagonism is afforded by determining the electrical resistance of living tissues. Toxic substances cause a fall of resistance, but if in a mixture of two such substances resistance falls less rapidly, it is evident that this is due to antagonism. In the case of the common kelp *Laminaria* $NaCl$ causes a fall of resistance while $CaCl_2$ causes a rise followed by a fall of resistance. In mixtures of $NaCl$ and $CaCl_2$ the resistance rises and then falls; by using the right proportions the fall may be made very gradual. We may explain these facts by assuming that the resistance is due to a substance, the production of which is accelerated by $CaCl_2$ while its decomposition is checked by a compound formed by the union of both $NaCl$ and $CaCl_2$ with a substance in the protoplasm. This throws new light on the manner in which salts act in preserving life. It has been found that the electrical resistance is a very delicate and accurate indicator of the vitality of protoplasm, since any kind of injury is at once indicated by a fall of resistance. This permits us to give a quantitative meaning to such terms as vitality, injury, recovery and death. The mechanism by which changes in resistance are produced by salts is therefore of great importance. The facts here presented give us a new insight into this mechanism.

Jointing as a Fundamental Factor in the Degradation of the Lithosphere: FREDERICK EHRENFELD. (Introduced by Professor Amos P. Brown.)

This paper is a study of those physical activities which are always at work to bring the surface of the earth down to a level or nearly flat surface. It includes also some discussion concerning the probable destruction of former great land masses or continents such as those believed by geologists to have existed formerly across the present oceans connecting Europe, Africa and America. In most text-books of the science the question of land surface leveling or degradation is considered more from the standpoint of the atmospheric or other surface cause than from the point of the construction of the solid portions of the earth itself. This the author of this paper considers a somewhat mistaken view to take of the case, as the stony mass or portion of the earth has been shown by many geologists to be subject to a constant fracturing or jointing which shows itself in various ways such as influence on river drainage, repeated groups of islands, bays along sea coasts and in certain types of volcanic and earthquake appearances. The paper discussed these and also the subject of marine planation to produce a lowering of the land below sea level. Illustrations of such marine action were shown from the Maine coast and also from the forms and positions of some of the Atlantic ocean islands. This subject of the action of the sea to produce a general leveling though a much discussed one some decades ago has been neglected by many modern students, but is now becoming prominent under newer ideas of the science, and this paper is in part a study of jointing in the mass of the lands to assist in such action and hasten continental land leveling and destruction by creating in the rock mass through joints great lines of weakness which under the attack of both the atmosphere and the sea compel the falling apart of the land. The question of former great land masses was discussed, as was also the bearing of these joints in the subject of the formation of coral reefs. In conclusion the author proposed a "law of joints" in which the controlling influence of joint lines was more definitely stated.

Sinking Islands versus a Rising Ocean in the Coral-Reef Problem: WILLIAM MORRIS DAVIS.

Since Darwin's voyage in the *Beagle*, eighty years ago, nearly all geologists who adopted his theory of coral reef accepted also his postulate that the reef-bearing islands have subsided with the subsiding ocean bottom. In later years, and largely under the leadership of the Austrian geologist, Suess, and the German geographer, Penck, the possible variation of ocean level around fixed islands has been emphasized. When it is seen that a rise of the ocean surface around still-standing islands would produce all the conditions that arise from Darwin's postulate of subsiding islands in an ocean of constant level, search should be made for some means of evaluating these two alternatives. The result of such a search shows that the theory of a changing ocean involves many extravagant complications which have not been sufficiently considered by those who accepted it; while the theory of subsiding islands is relatively simple and economical. Darwin's original theory is to be preferred on those grounds.

The Petrology of Some South Sea Islands and its Significance: JOSEPH P. IDDINGS.

The islands of Tahiti, Moorea, Huaheine, Raiatea, Tahaa, Bora Bora of the Society group, and Hiva-oa and Nukahiva of the Marquesas were visited in order to ascertain whether the volcanic rocks composing them are of such a character that they support the theory of isostasy, which demands that the deep portions of the earth's crust, or the lithosphere, under the Pacific Ocean should consist of heavier material than that underlying the continent of North America. It was found that the volcanic rocks of these islands are noticeably heavier on the average than the igneous rocks occurring in various parts of the American continent. Each of the islands visited was found to be an extinct basaltic volcano, considerably eroded, and partly submerged beneath the sea. The structure and rocks of the islands are briefly described and characteristic views are shown by means of lantern slides.

Coal Formation: J. J. STEVENSON.

The doctrine that the fossil fuels from peat to anthracite are a continuous series has been subject of renewed discussion within recent years. The writer felt compelled to make serious investigation to free himself from doubts aroused by the statements of some authors. The study proved unexpectedly difficult, for the disputants have very little common ground and one can hardly determine what kind of evidence may be acceptable to all. Some collateral matters, of much importance, have been overlooked and little information exists respecting them. These are chiefly chemical and the studies require extensive equipment as well as expenditure of much time, neither of which is at the writer's disposal. But assurances have been received from the presidents of several great organizations that the investigations will be made and that the results will be in readiness for the final summary. The general study has advanced so far, in the writer's opinion, as to justify presentation of the first part of his monograph. The plan adopted is to discuss the fuels in order of age, beginning with peat and closing with the Paleozoic coals. The first part considers peat and the Tertiary coals; the second will consider the Mesozoic and the Paleozoic coals. The writer hopes to make evident the inherent probability of the doctrine that, in spite of difference in plant materials, the coals throughout form a connected series, not merely in mode of accumulation, but also in physical structure and in chemical composition.

California Lakes and the Solar Hypothesis of Climatic Changes: ELLSWORTH HUNTINGTON.

Color Photographs of the Phosphorescence of Certain Sulphides: EDWARD I. NICHOLS.

By the use of a new form of phosphorescope the author has succeeded in taking photographs by the Lumière process, which shows the colors of certain phosphorescent sulphides of the Lenard and Klatt series. The change of tint by decay and the striking changes of color produced by cooling to the temperature of liquid air are exhibited by means of these photographs and the theory is very briefly discussed.

FRIDAY, APRIL 14

Afternoon Session—2 o'clock

William B. Scott, Sc.D., LL.D., Vice-president, in the Chair

A New and very Sensitive Indicator for Acidimetry and Alkalimetry and for Determining Hydrogen Ion Concentrations between the Limits of 6 and 8 on the Sorensen Scale: G. SCATCHARD and MARSTON T. BOGERT.

The authors have discovered that dinitro benzoylene urea (dinitro 2-, 4-diketotetrahydroquinazoline $\rightleftharpoons$ dinitro 2-, 4-dihydroxyquinazoline) is an unusually sensitive indicator and one which can be prepared easily, in any desired amount, from anthranilic acid. It changes from colorless to greenish yellow with a change in hydrogen ion concentration from 10^{-6} to 10^{-8}, the development of the coloring following regularly the decreasing concentration of hydrogen ion. It is very little affected by neutral salts or proteins, and not at all by the ordinary biological preservatives, chloroform and toluene. The color does not fade perceptibly in two days, and but very slightly in a week. It therefore promises to be very useful in the measurement of hydrogen ion concentration of biological or other liquids in this important range, for which the previously known indicators are not very satisfactory. It is possible with it to detect the effect of one drop of N/100 NaOH in 100 c.c. of solution, and titrations of N/100 HCL with N/100 NaOH checked within 0.L per cent. Under similar conditions -nitrophenol required 5 to 6 drops, and methyl orange 10 to 12 drops, to give a sure end-point. Its chief objection is its yellow color, which renders it unsuitable for determinations in artificial light.

Bacterio-chemical Studies of Decay of the Teeth: WILLIAM J. GIES.

The Human Gastric Secretion: MARTIN E. REHFUSS. (Introduced by Dr. Philip B. Hawk.)

Cerebral Localization: HARVEY CUSHING. (Introduced by Dr. Keen.)

The Inorganic Constituents of Marine Invertebrates: FRANK WIGGLESWORTH CLARKE.

It is a commonplace of geology that many limestones are formed from the remains of marine animals, such as corals, mollusks, crinoids, etc. Some of these limestones are magnesian, some are phosphatic and others are of the ordinary type, consisting chiefly of calcium carbonate. They were originally deposited at the bottom of the sea, and their composition depends upon the composition of the organisms which formed them. The present investigation has for its purpose to determine what each group of organisms contributes to the sediments; and in order to answer this question nearly 250 analyses have been made of the shells or skeletons of marine invertebrates, covering a range from the foraminifera up to the crustacea, and including also the corellin algæ. It was already well known that corals and molluscan shells were composed almost entirely of calcium carbonate, and that fact has been verified. The shells of one group of brachiopods, however, consist largely of calcium phosphate, and that substance is also abundant in the crustacea. These animals, and also vertebrate skeletons, contribute phosphates to the sediments. The foraminifera, alcyonaria, sea fans, echinoderms and calcareous algæ, with some minor groups or organisms, contain much magnesia, and therefore aid in the formation of magnesian limestones. Curiously enough, the amount of magnesium carbonate in any series of organisms varies with the temperature of the water in which the creatures lived; being small in cold and large in warm waters. A sea urchin from Greenland, for example, contained 6 per cent. of magnesium carbonate, and one from near the equator contained over 13 per cent. In certain algæ from the West Indies 25 per cent. was found. Furthermore, some organisms have their calcium carbonate in the form of aragonite, and others consist of calcite. The aragonitic organisms are all non-magnesian; while the magnesian forms are all calcitic. The data obtained in this investigation have been applied to the study of coral reefs, which owe their composition to all the creatures living upon them, and not to the corals alone. In fact, the corals are often of less importance than their associates.

Some Properties of Vibrating Telephone Diaphragms: A. E. KENNELLY and H. O. TAYLOR.

(A) Dimensional Gases and the Law of Reflection of Gas Molecules from Solid Walls. (B) The Metallic Reflection of Light from a Gas: ROBERT WILLIAMS WOOD.

Some Relations between Matter and Radiation: WILLIAM DUANE. (Introduced by Professor A. W. Goodspeed.)

To Benjamin Franklin we owe the fundamental conception that the phenomena of nature are due largely to the interaction of atoms of electricity with atoms of ordinary matter, and the object of this paper is to discuss the emission of radiant energy (light, heat-rays, X-rays, etc.) from the point of view of Franklin's conception. Since the discovery, some years ago, of cathode rays, X-rays and radioactivity scientists have had in their hands the means of producing and studying streams of atoms of both electricity and ordinary matter. They have succeeded even in observing effects due to a single atom of each kind. We now know that the impacts of atoms of electricity against atoms of ordinary matter produce radiation. Mr. Hunt, Dr. Webster and the author have been investigating the relations between the energy of the atom of electricity and the frequency of the radiation it produces. The most striking facts we discovered are that in the case of the so-called *general radiation* the energy required is strictly proportional to that frequency, and in the case of the so-called *characteristic radiation* the energy required is larger than in the preceding case and not always proportional to the frequency. The author offered the following explanations of these facts. High frequency vibrations are associated with the central parts of an atom of matter, in which the electromagnetic field is very strong. In order to reach a point in an atom of matter where a given frequency of vibration is produced the atom of electricity must have at least enough energy to overcome a certain force of repulsion acting between them. If we follow out the line of reasoning and apply Maxwell's distribution law and what has been called the fourth power law to the case of the atoms of electricity flying about in a hot body owing to its thermal agitation, we arrive at an equation for the distribution of energy in the spectrum that represents the facts with considerable precision. The above mentioned laws discovered by experimental investigation have a practical bearing on X-ray phenomena also. They indicate what must be done in order to produce those very high frequency radiations that hitherto have been obtained from radioactive substances only.

Relation between Changes in Solar Activity and the Earth's Magnetic Activity, 1902–1914: Louis A. Bauer.

No criterion of solar activity, whether it be the spottedness of the sun, or the faculæ, prominences, or calcium flocculi, has been found to synchronize precisely with any quantity used as an index of the earth's magnetic activity. Thus, for example, the maximum magnetic activity in 1892 preceded the maximum sunspot activity of that period by a year. So again the recent minimum magnetic activity of the earth seems to have occurred in 1912, whereas the minimum sunspot activity did not take place until 1913, or a year later. Then again the amount of magnetic activity is not necessarily commensurate with that of solar activity, whatever measure of the latter be used. When the comparisons between the solar data and the magnetic data are made for intervals of less than a year, a month for example, as was done in my paper before this society in 1909, the lack of exact synchronism and the lack of proportionality between the two sets of changes become especially noticeable. Fortunately, beginning with 1905, we have a new set of figures, the values of the solar constant, determined with high precision at Mount Wilson, California, by Dr. Abbot. Remarkable fluctuations are shown in these values, amounting at times to 10 per cent. of the value. The present paper makes a comparison between the annual changes in the values of the solar constant for the period 1905 to 1914 with the irregularities in the annual changes of the earth's magnetic constant. It is found that the two sets of data, in general, show similar fluctuations. Also, a closer correspondence is found between those two sets of changes than between either set and that of sunspot frequencies. In brief, the solar-constant values furnish another index of changes in solar activity which may be usefully studied in connection with minor fluctuations in the earth's magnetism. In conclusion, it was pointed out why none of the mentioned criteria of solar activity can be used as an adequate measure of the various ionizing agencies ultimately responsible, according to present belief, for the magnetic changes recorded on the earth.

FRIDAY EVENING, APRIL 14

Reception from 8 to 11 o'clock at the hall of the Historical Society of Pennsylvania, S.W. corner of Locust and Thirteenth Streets, at 8:15 o'clock. Leland O. Howard gave an illustrated lecture "On Some Disease-bearing Insects."

SATURDAY, APRIL 15

Executive Session—9:30 o'clock

Stated Business.—Candidates for membership balloted for. As a result of the election the following were elected as members of the society:

Residents in the United States

William Wallace Atterbury, A.M., Radnor, Pa.; Maxime Böcher, A.B., Ph.D., Cambridge, Mass.; Percy William Bridgman, Ph.D., Cambridge, Mass.; James Mason Crafts, S.B., LL.D., Boston, Mass.; Henry Platt Cushing, Cleveland, Ohio; Edward Murray East, M.S., Ph.D., Boston, Mass.; Frank Rattray Lillie, Ph.D., Chicago, Ill.; William E. Lingelbach, A.B., Ph.D., Philadelphia; Daniel Trembly MacDougal, A.M., Ph.D., Tucson, Ariz.; Charles Frederick Marvin, M.E., Washington, D. C.; Lafayette Benedict Mendel, A.B., Ph.D., Sc.D., New Haven, Conn.; Forest Ray Moulton, Ph.D., Chicago, Ill.; Eli Kirk Price, A.B., LL.B., Philadelphia; Erwin Frink Smith, Sc.D., Washington, D. C.; William Morton Wheeler, Ph.D., Boston, Mass.

Foreign Residents

Frank Dawson Adams, D.Sc., Ph.D., F.R.S., Montreal; Wilhelm L. Johannsen, M.D., Ph.D., Copenhagen; Joannes Diderik van der Waals, Ph.D., Amsterdam.

Morning Session—10 o'clock

Edward C. Pickering, D.Sc., LL.D., F.R.S., Vice-president, in the Chair

Age Cycles and Other Periodicities in Organisms: C. M. Child. (Introduced by Professor C. E. McClung.)

Experiments with various forms among the lower invertebrates show that senescence occurs in those forms as in the higher animals, but that rejuvenescence also ocurs in asexual reproduction, in the reconstitution of pieces experimentally isolated and also during starvation. These organisms may pass through alternating periods of senescence and rejuvenescence without death and often without reproduction. The experimental evidence indicates that senescence consists physiologically in a decrease in the general metabolic rate, conditioned by the modifications of the colloid substratum and the progressive accumulation of relatively stable structural substances during growth and differentiation. Rejuvenescence is physiologically an increase in general metabolic rate conditioned by the chemical breakdown and removal of such modifications under certain physiological conditions. The sex cells are physiologically old, highly differentiated cells and the early stages of embryonic de-

velopment constitute a period of rejuvenescence. Many other periodicities in organisms are of the same general nature as the age cycle. Fatigue, recovery, the loading and discharge of gland cells, various seasonal periodicities, alternating active and quiescent periods, etc., depend to a greater or less degree on modifications of the protoplasm by metabolism and the following removal of such modifications under altered metabolic conditions.

Cooperation as a Factor in Evolution: WILLIAM PATTEN. (Introduced by Professor H. H. Donaldson.)

The purpose of this discussion is to show that cooperation, or the summation of power, is the creative and preservative agent in evolution, and that the summation of power depends on cooperation in the conveyance of power. The *vis a tergo* in life is the product of internal cooperative exchange (metabolism). Growth is profitable exchange, or the increase of the power of exchange due to the local accumulation of those agents whose demands are the impetus to exchange. The rate at which growth proceeds depends on the capacity of its conveyers, that is on their capacity to convey things to and from the growing points, or the growing points to the sources of supplies. Growth creates a power which is used as a means to satisfy its own demands, and a surplus power for "freedom" of action, which is used to experiment and explore, or to find better ways and means of satisfying its demands. Growth, therefore, follows the easiest, most accessible, and most profitable lines of conveyance, and its products accumulate along the lines of least resistance. Growth inevitably creates diversified conditions which tend to check its own progress till relieved by better cooperation. For growth reduces the immediately available supplies, thereby requiring greater expenditures to procure them; and the new internal conditions created by growth create new products, with new demands, faster than the right ways of ministering to them can be found. The larger demands, under reduced resources, can only be supplied by better cooperation in the common service of conveyance; but as fast as these demands are satisfied, producing new growths, further demands are created, to satisfy which requires still better methods of cooperation. The same laws which prevail in the inner and outer life of animals and plants prevail in the social life of man. Man's social progress is measured by the degree to which he has extended the mutually profitable give and take of cooperative action beyond himself, to the family, tribe, state and into the world of life at large. The chief agents of civilization, language, commerce, science, literature, art and religion are the larger and more enduring instruments of conveyance, which better enable the part and the whole to avoid that which is 'evil" and to find that which is "good," and which yields a larger surplus for "freedom."

On the Effects of Continued Administration of Certain Poisons to the Domestic Fowl, with Special Reference to the Progeny: RAYMOND PEARL.

Types of Neuromuscular Mechanism in Sea-Anemones: GEORGE H. PARKER.

In the origin of nerve and muscle the sea-anemone has been supposed to represent a step in which a nervous set of very primitive structure could throw into prolonged contraction the general musculature of the animal's body. An examination of the body of the sea-anemone shows that its muscular activities are of a much more diverse kind. They include, first, muscles that act under direct stimulation and without the intervention of nerves; secondly, muscles that are stimulated directly as well as by nerves; thirdly, muscles that are stimulated only by nerves and exhibit under these circumstances profound tonic contractions; and, finally, muscles that react in the same reflex way that those in the higher animals do. This diversity of muscular response has not been fully appreciated by previous workers.

Determination of Stellar Magnitudes by Photography: EDWARD C. PICKERING.

An immense amount of work is being carried on by observatories all over the world, in determining the photographic magnitudes of the stars. It is of the utmost importance that all of these magnitudes should be reduced to the same scale. Accordingly, in April, 1909, an International Committee was appointed with members from England, France, Germany, Holland, Russia and the United States. This committee met in 1910 and 1913, and, after a most amicable discussion, agreed on a system, in which all stars were to be referred to a Standard Sequence of stars near the North Pole. The magnitudes of the latter were determined at Harvard by Miss H. S. Leavitt, by six different methods, using eleven different telescopes, having apertures from one half to sixty inches. All gave accordant results, and were adopted by the committee. A simple method was found for transferring these magnitudes to stars in other parts of the sky, but here extraordinary sources of systematic errors presented themselves. For in-

stance, if two equal exposures were made on a plate, the second was found to give fainter images; if, by means of a small prism, exposures were made simultaneously with different apertures, the smaller aperture indicated a brighter magnitude than the larger, when the stars were bright, and a fainter magnitude when they were faint. The color equation was found to vary by different amounts not only for different instruments, but for different magnitudes.

Monochromatic Photography of Jupiter, Saturn and the Moon. (Illustrated by Color-photographs made with the Mt. Wilson 60-inch telescope): ROBERT WILLIAMS WOOD.

On the Eclipses of Jupiter's Satellites: JOHN Q. STEWART. (Introduced by Professor H. N. Russell.)

On the Probable Temperature of Mars: HENRY NORRIS RUSSELL.

A New Catalogue of Variable Stars: ANNIE J. CANNON. (Introduced by Professor E. C. Pickering.)

The first variable star was discovered in 1596, and two hundred years later, when the first Catalogue was made, there were but twelve known. A catalogue of 113 variable stars was published in Germany in 1865. In 1888 when the first catalogue of them was made in America, the list contained 225 stars. About this time, the Harvard photographic work was established by the director, E. C. Pickering. One of the first results of a study of these photographs was the discovery of large numbers of variable stars. They were found by four methods: by arranging groups of stars in sequences; by the presence of bright lines in their spectra, when photographed with an objective prism; by multiple exposures on the same stars throughout the whole night; and by superposing a glass positive and negative of the same region. The globular clusters, the Magellanic clouds, and the map of the sky have proved fruitful fields for this investigation. So great has been the increase in number that a new Catalogue now being compiled contains 4,641 stars, of which 3,397, or nearly three quarters of the whole, have been found at Harvard, and 1,244 elsewhere, by astronomers in nearly all portions of the civilized world. The variable stars are divided into five classes, dependent upon the character of their variation in light. The periods vary from two hours to 698 days. Determination of the periods and light curves of these stars constitute a large piece of work. Much has been done at Harvard in this field, and many observations have been furnished other astronomers for such determinations. No more suitable place could be found for the preparation of this catalogue than the Harvard Observatory, for the rich library of a quarter of a million stellar photographs furnishes the only complete material in the world for the study of these stars during the last twenty-five years. By examining the past history of a star on these photographs, the investigator may far more readily find an answer to such perplexing questions as to whether a star is variable or constant, what is the length of the period, is the period changeable, what is the color or the spectrum of the star, than by waiting months or years to accumulate additional observations.

Legal and Political International Questions and the Recurrence of War: THOMAS WILLING BALCH.

SATURDAY, APRIL 15

Afternoon Session—2 o'clock

William W. Keen, M.D., LL.D., President, in the Chair

Symposium on International Law: Its Foundation, Obligation and Future:

Outline: HON. JOHN BASSETT MOORE.

Judicial Aspects: International Arbitration: HON. CHARLEMAGNE TOWER.

Legislative Aspects: GEORGE GRAFTON WILSON. (Introduced by Hon. John Bassett Moore.)

Administrative Aspects: PHILIP MARSHALL BROWN. (Introduced by Hon. Charlemagne Tower.)

World Organization: HON. DAVID JAYNE HILL.

On Saturday evening, April 15, at 7:30 o'clock, the annual dinner was held in the North Garden of the Bellevue-Stratford, at which more than one hundred members and guests were present. The president was particularly happy and witty in his introductions of the speakers, who responded to the toasts as follows:

"The Memory of Franklin," by Professor A. Trowbridge.

"Our Sister Societies," by Professor R. A. Millikan.

"Our Universities," by Professor J. M. Coulter.

"The American Philosophical Society," by Professor F. E. Schelling.

Thus ended perhaps the most notable meeting since the Franklin Celebration.

ARTHUR W. GOODSPEED

PHILADELPHIA,
April 17, 1916